November/December 1980
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American Productivity: The Sun Also Rises

The French Nuclear Connection
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Communications: The Big Picture

Technology Review

Edited at the Massachusetts Institute of Technology

The Creation of Engines:

New Power from Detroit?

technology
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SCIENCE/SCOPE

Water levels in cooling systems of nuclear reactors may be monitored more reliably, especially during an emergency core shutdown, by a metal-coated optical fiber developed by Hughes. The thin glass thread, some 1000 of which would be placed around a reactor's core, is tipped with a sapphire retro-reflector. Unlike plastic-coated fibers, it can withstand the harsh reactor environment of temperatures as high as 350°C and pressures up to 1800 pounds per square inch. Compared to resistive level sensors now in use, the fiber is a model of simplicity. The sapphire tip, when dry, reflects light transmitted through the fiber; when wet, it reflects no light. Prototype sensors were developed under Nuclear Regulatory Commission sponsorship.

Data rates of 4 billion bits per second -- a speed at which the Encyclopedia Britannica could be transmitted in just two seconds -- have been demonstrated by an experimental modulator at Hughes. The modulator, an important step toward ultra high-speed satellite communications, is a quadriphase shift-keyed arrangement of two field-effect transistor biphase modulators. Use of microwave FETs in the modulator driver circuit resulted in very low power consumption.

Doctors can look into the human body more clearly, quickly, and safely than ever before by using a new x-ray process called computed axial tomography. The process employs a sophisticated scanner to create pictures of one plane of the body. One benefit is that doctors have more detailed views of bones and organs. Also, because the scanner contains extremely sensitive photodetectors, patients receive much smaller doses of radiation. Hughes photodiodes are used in these instruments to detect scintillations produced by the x-rays.

If you're pursuing a Master's or Doctoral degree in Engineering (Electrical, Electronics, Systems, Mechanical), Computer Science, Applied Mathematics, or Physics, you might qualify for one of 100 fellowships Hughes will award this year. Recipients will have all academic expenses paid and will receive an educational stipend, summer employment, professional salary, and employee benefits. Already 4,000 engineers and scientists have used the program to achieve their advanced degrees. For more information, write: Hughes Aircraft Company, Corporate Fellowship Office, Bldg. 6/C122/SS, Culver City, CA 90230. Hughes is an equal opportunity employer.

For the first time a new microwave sensor will allow military weather satellites to "see" through clouds to monitor meterological conditions below. The instrument will detect rainfall, ice masses, ocean wind speeds, soil moisture content, and other conditions, and relay compiled data within minutes nearly anywhere in the world. Data will help commanders plan operations that depend on accurate weather forecasts. Hughes, under a U.S. Air Force contract, is to build one prototype and develop computer software for ground processing.

Creating a new world with electronics

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A Tidal Wave of Microprocessors

Microprocessors — small computers that, because of advanced electronic technology, have been compressed to fit in tiny packages — are showing up in increasing numbers as components of other machines and consumer items in which computers have never before been used. Like the larger computers, microprocessors may be instructed or programmed to perform a variety of different tasks. Microprocessors can currently be found in automobiles to regulate carburation and calculate miles-per-gallon, in telephones to remember commonly used numbers, and in microwave ovens that turn themselves on and off according to instructions. Though these features have been well accepted by customers, the movement toward the use of microprocessors is not really a response to a desire by the consumer for more "bells and whistles"; it is a matter of simple economics.

According to Professor Myron Tribus, director of the Center for Advanced Engineering Study and former vice-president of the Corporate Research Staff of Xerox Corp., the "main driving force" behind the use of microprocessors is the increase of product quality and reliability and the reduction of maintenance costs.

The microprocessor can increase product quality by continuously fine-tuning the device in which it is installed. This is the principal reason behind their use in automobile fuel and exhaust systems, according to Paul Wetzel, General Motors' public relations manager for New England. The new computer-controlled catalytic converter system that will be installed in all 1981 GM cars will monitor such outside operating conditions as temperature, humidity, and air pressure and then adjust the air-fuel mixture in the carburator to decrease emissions.

The use of feedback — monitoring a device to change its operation on the basis of its output — is one of the ways Xerox uses microprocessors to improve the quality of copying machines, explains Dr. Tribus. "In the copying machine, we add feedback loops to check the lamp brightness, the charge on the drum, and other points. The microprocessor adjusts the operating parameters and the result is an accurate, good-quality copy."

Although microprocessor circuits can be expensive, their cost can be more than offset by increased reliability and decreased maintenance. Microprocessors in Xerox's model 5400 copier continuously check 30,600 spots in the machine for paper jams and stop the machine before damage occurs. In some 1980 cars, a microprocessor checks the lights, brakes, turn-signals, engine temperature, and generator and warns the driver if a hazardous condition exists.

In addition, microprocessors can decrease repair costs by aiding service personnel in locating problems. Honeywell Information Systems has been putting self-diagnostic capabilities into its minicomputer systems for many years, and Xerox has been using the same systems in its copiers. Dr. Tribus explains that by checking various points in the copier and responding to queries, the microprocessor aids the repairperson in locating service problems, decreasing service time and costs.

To achieve these goals of higher quality and reliability and decreased maintenance costs, computer-type circuits will soon be included in devices that do not seem to require a hint of computing. Herbert Kleinman, managing consultant at Booz, Allen, and Hamilton, Inc., told the *Wall Street Journal* that the use of microprocessors is increasing like "a tidal wave that will have a momentous impact on many industries. What's happening now is peanuts compared with what will happen in the next decade." — *Craig Goldman, '80* □

Regulation as a Fount of Innovation

Is government regulation stifling technological change in American industry?

In most industries, and in most companies, the answer seems to be no, say Professor Nicholas A. Ashford and George R. Heaton of M.I.T.'s Center for Policy Alternatives.

Surveying 50 firms in chemical manufacturing dealing with four highly regulated chemicals, Professor Ashford and Mr. Heaton found no regulation presenting "an insurmountable technical problem." All the companies succeeded in making technological changes — sometimes significant innovations — to comply with regulations and retain economic viability.

But an analysis of how the different industries — and the different companies — have accomplished these changes has yielded some interesting and surprising results:

□ Almost without exception, established industries seek to change as little as possible to achieve compliance with a new health or environmental demand. Across an industry, individual companies, responses to health and environmental regulation were highly uniform. Older regultions, such as air and water pollution requirements — though they induced technological change — did not have much leverage on innovation. However, more process-foucused regulation, such as occupational safety and health or consumer product safety regulation, may stimulate new product development.

□ Firms in "rigid" industries, where technologies are narrow and well defined, seem especially likely to reach for creative solutions to severe regulatory problems.

□ Technological change stimulated by new regulation often comes from outside the industry. Indeed, new rules may encourage new entrants in a field. This happened, for example, when PCBs were banned: transformer/capacitor manufacturers, which had used PCBs but had never made them, made aggressive and successful searches for substitutes.

□ Many firms respond to regulation by changing the mix of skills represented in their research and development laboratories — more emphasis, for example, may be placed on analytic chemistry. And it is through these changes that health and environmental regulations may ultimately have their most significant impact on future innovation. Already, 10 of the 50 companies surveyed by Professor Ashford, Mr. Heaton, and their colleagues said that they had made "ancillary innovations resulting from regulation" with benefits in "areas not related to compliance." Examples: a new catalyst for petroleum refining, a new chlorine manufacturing process, new paint formulations, and increased yields of PVC resin.

Corporation Nominee

One member of the Classes of 1979, 1980, and 1981 will be chosen in a national ballot of recent graduates next May for a five-year term on the M.I.T. Corporation. Suggestions for nominees are needed (before Dec. 19) by the Screening Committee, Room 10-110, Ext. 3-8200.

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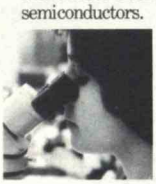
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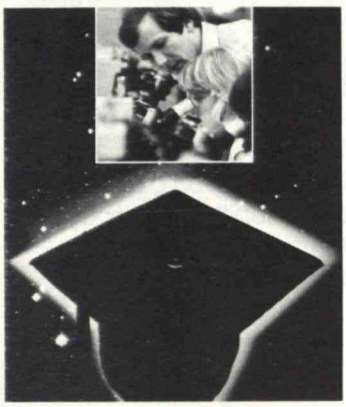
- The world's leading supplier of semiconductors.



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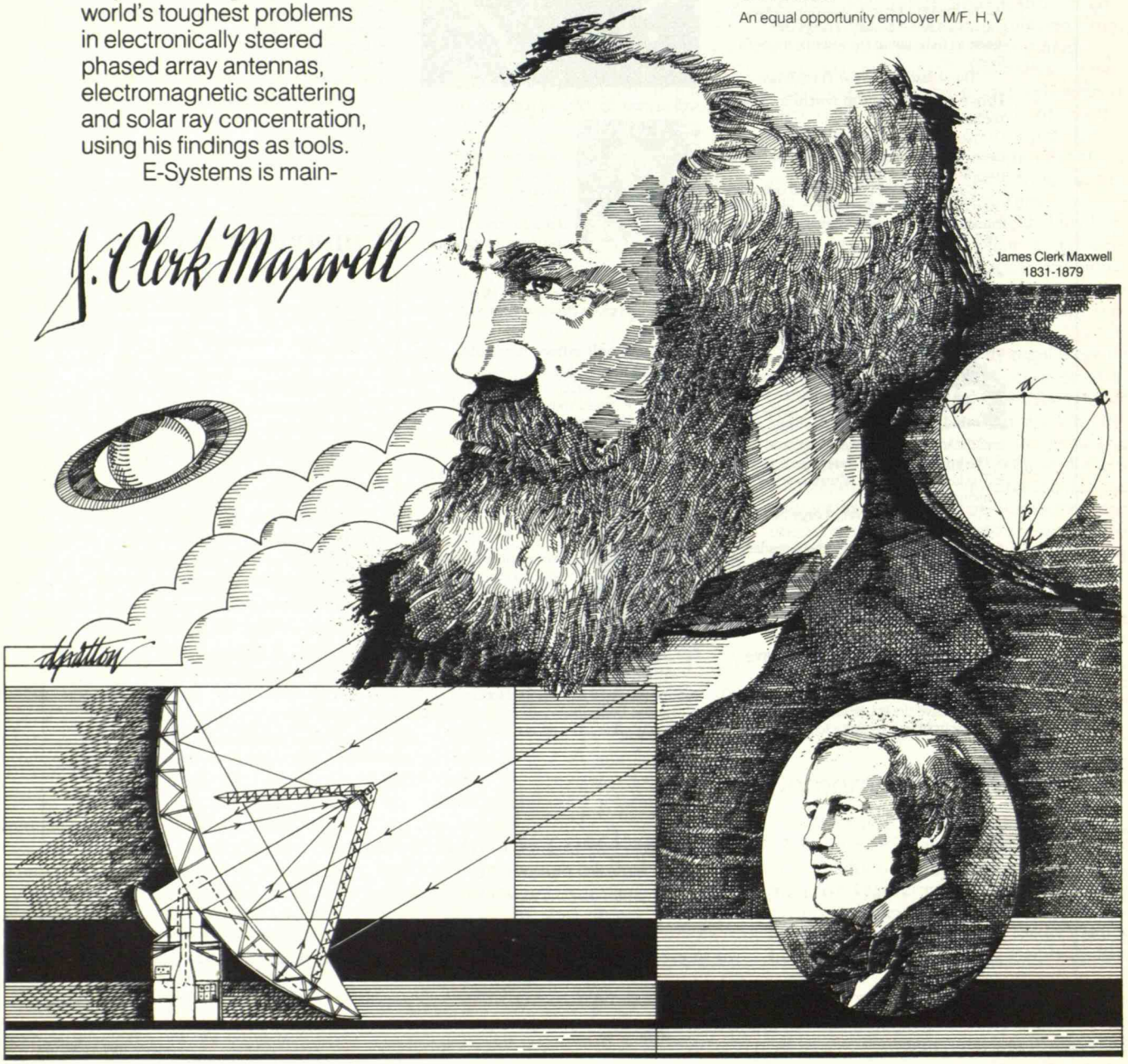
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Letters

Evaluating Risk Consistently

Technology Review is to be congratulated for "Reducing Occupational Health Risks: Uncertain Effects and Unstated Benefits" by John Mendeloff (*March/April, p. 38*) and Richard Wilson's "Analyzing the Daily Risks of Life" (*February 1979, p. 40*). Taking these articles together, one sees that nothing is risk free, and that regulatory agencies must not only effectively target dollars spent on risk regulation but also make intelligent choices among risks.

I have introduced in the 96th Congress H.R. 4939, which would establish a mechanism within the regulatory process for assessing comparative risks involved in policy choices concerning public health and safety.

A comparative-risk approach complements rather than substitutes for risk-benefit analysis because it can target areas of primary concern. This approach seems to deal with questions of effectiveness and efficiency as well as provide the public with a better understanding of the relative dangers of medical drugs, pollutants, food additives, energy sources, and other potential hazards. Requiring a uniform approach to setting priorities may also help remove inconsistencies among the various agencies.
Don Ritter
Washington, D.C.

The writer is a member of the U.S. House of Representatives. — Ed.

Protecting and Selecting Fetuses

Two Trend of Affairs articles (*March/April, pp. 76-77*) suffer from a naivete that I prefer not to associate with *Technology Review*.

"Toxic Chemicals and Reproduction" by S.J.M. discusses this issue as if it involved a difference between men and women, when in fact it is a distinction between persons capable of becoming pregnant and those not. A fetus is typically 100 times more sensitive than a mature person and therefore requires either exclusion or protection at two orders of magnitude greater than other individuals.

The validity of "The Implications of Sex Preselection" by K.R. depends on whether one believes Roberta Steinbacher, who is not sufficiently familiar with the literature on sex ratio, statistical methods, or scientific proof. "Sex control" has been seriously discussed and routinely reported for at least half a century. Unfortunately, second and third reports of success are as routinely missing; selective abortion is the only method currently able to produce the desired results. Thus, the last quotation in the article is simply false: serious discussion of sex preselection has at least kept up with the technologies.
C. Ralph Buncher
Cincinnati, Ohio

The writer is professor of epidemiology and biostatistics at the Institute of Environmental Health at the University of Cincinnati.

Steven J. Marcus responds:
Of course a fetus is more sensitive than a mature person, but not all female workers are pregnant.

Karen Ray responds:
The point is that it is essential to discuss the implications of sex preselection technologies. While Dr. Steinbacher's conclusions are evidently not accepted by Dr. Buncher, they do not necessarily "suffer from a naivete."

Hazards of Cigarette Smoke

If the average size of sidestream particles from cigarettes is 0.15 centimeters (*"Particulates and Cigarettes," March/April, p. 2*), a jogger could bruise his or her face by running past a smoker.
C. Robert Keppel
Omaha, Neb.

The writer is professor of chemistry at the University of Nebraska at Omaha. The units should have read microns. — Ed.

How France Is Governed

In "How Prometheus Came to Be Bound" (*June/July, p. 28*), it was stated incorrectly that all the foreign countries examined have parliamentary systems of government. This was technically in error: since 1958, the French government has been presidential in form. However, the country continues to function as a parliamentary democracy, with control of both the legislative and executive branches held by the same party, which imposes strong internal discipline. Thus, the technical error does not affect the substance of the article.
— Michael Golay

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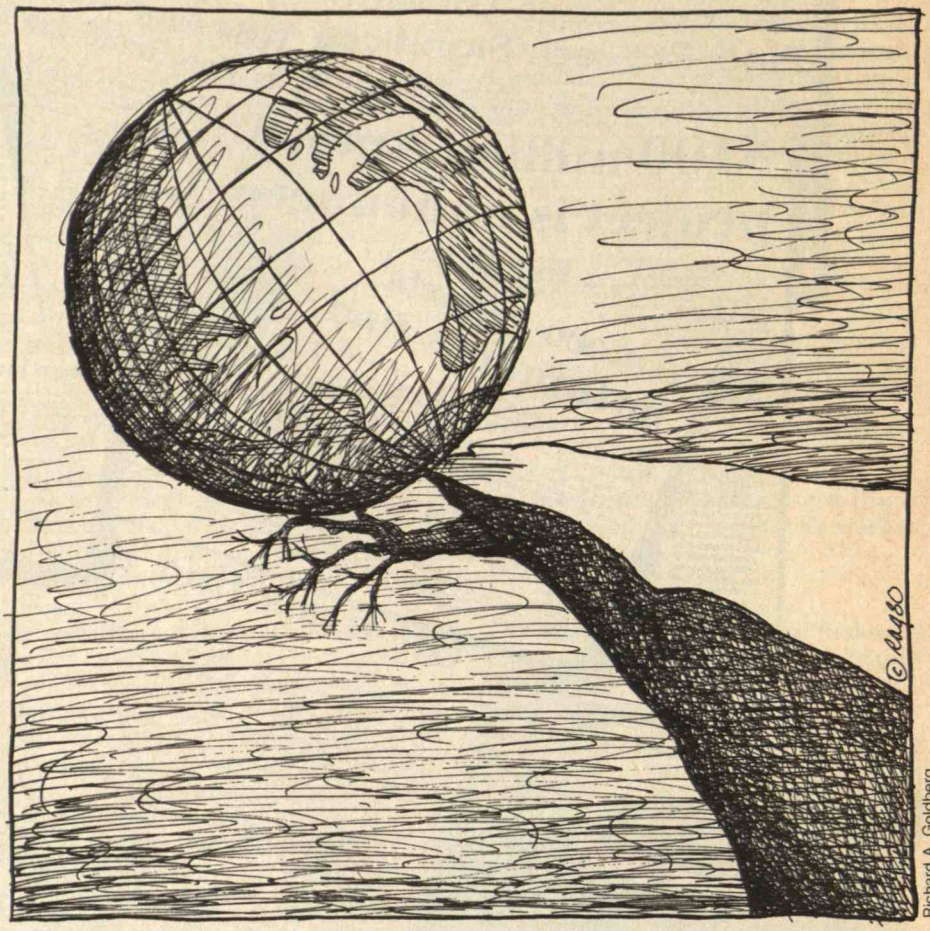
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The Catastrophe That Wasn't



Kenneth E. Boulding is a program director at the Institute of Behavioral Science and distinguished professor emeritus of economics at the University of Colorado at Boulder.



Richard A. Goldberg

This summer hurricane Allen, purported to be the largest Caribbean hurricane in many years, was a great disappointment to those readers of newspapers whose eyes glint eagerly at stories of catastrophe. Although the storm did some damage and claimed a few lives, the loss could have been far more tragic. The storm's intensity had diminished before hitting the coast, but also remarkable precautions and evacuations were successfully carried out on the Texas coast. This is in striking contrast to the devastating hurricanes of earlier years, some of which killed thousands of people. The good news is no news, which is perhaps just as well. If good things became news we would have something to worry about — this would be a sign of their dramatic scarcity.

Doomsterism, the prediction of catastrophe, has been a popular human exercise for a long time. It was popular, I am sure, long before Jeremiah, who has hardly been surpassed. One has to admit that doomsters are often right; certainly Jeremiah was. The propensity for catastrophe is probably one of the basic laws of the universe. It may well be that catastrophes have played an important role in evolution itself.

From the earliest times, human beings have surrounded themselves with artificial environments such as houses, clothing, and food stores that are more stable than "natural" external environments. A naked human on the Texas beach would have had a rather rough time against Hurricane Allen, as would someone in a tepee. Anyone in a well-built house with a cellar had a much better chance of surviving. Our "conquest of nature" is a misnomer. We do not conquer nature, we just isolate ourselves from her bad moods by making safer artificial environments.

The best doomsters, of course, are those whose predictions are self-defeating: they arouse behavior that avoids the doom. Jeremiah probably had that ambition, but Israel, alas, did not repent and was carried off into captivity. A doomster whose credibility is destroyed by too many false alarms is unlikely to succeed in the self-defeating prophecy. Our theory tells us that there is a trade-off between false alarms and valid predictions. In a world as uncertain as this, some false alarms are the price we have to pay for any kind of warning system, but it's hard to determine where the optimal trade-off lies.

The Hurricane Allen experience suggests that better adaptation to natural catastrophes is not an unreasonable hope. We can do better protecting ourselves from floods, earthquakes, and perhaps even tornadoes, but it is easier to adapt to the more dramatic catastrophe than the long-run catastrophe such as climatic change. Here our ignorance of the system in which we live is substantial, because we have been observing it carefully for such a short time. For instance, we know very little about the long-run dynamics of the sun or even the earth, and the sources of climatic changes are still quite mysterious.

Of course, the human race has adapted to quite severe climatic changes such as ice ages and the passing of ice ages. There is enough evidence for what might be called the "Mesolithic deterioration" to suggest that these adaptations are not always pleasant. At a conference on the CO_2 problem last year, all the physical scientists and climatologists were gloomily contemplating the slippage of the west Antarctic icecap, a rise of 25 feet in the level of the oceans, the desertification of the Middle West, the shift of climate zones, and so on, effects that now seem much less probable than they did a couple of years ago. However, the economists were cheerfully calculating how much it would cost to truck the soil of a desiccating Iowa up to the soilless but benign climate in the Laurentian shield — it turned out to be rather expensive! Again, there seems to be no word for a long-range change for either the worse or the better; even the word "erosion" is too specialized.

Continued on page 76

Myth:

Truck trailers on the public highways move freight most efficiently.



Fact:

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Congress watchdog, the General Accounting Office, said in a blistering July 1979 report: "Excessive truck weight is a major cause of highway damage. The rate of highway deterioration will slow down if excessively heavy trucks are kept off the highways...A five-axle tractor-trailer loaded to the current 80,000 pound federal weight limit...has the same impact on an interstate highway as at least 9,600 automobiles."

It is ironic that the American public is subsidizing the destruction of its own highways. It is also unnecessary, because a logical alternative already exists. This is the vast, fuel-efficient steel network that links every part of America: our modern freight railroads.

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UFOs: Fact and Frivolity



Robert C. Cowen, science editor of the Christian Science Monitor, *is former president of the National Association of Science Writers and a regular contributor to the* Review. *He holds S.B. and S.M. degrees in meteorology from M.I.T.*



Roger Leyonmark

J. Allen Hynek, the astronomer who has come to symbolize the scientific investigation of UFOs (unidentified flying objects), was striving to find common ground with his colleagues. "Our purpose," he said, "is to determine as best we can whether the UFO phenomenon is trivial or cloaks something of importance . . . Scientific questions are resolved by hard work." With this, there was no disagreement from his five fellow panelists at an unprecedented symposium organized by the Smithsonian Institution in September. However, some of them may have wished he would put more emphasis on the "hard work" and less on speculations of alternative realities and dubious encounters of the third kind. Yet the mere fact that this conservative institution would hold such a symposium and could find six credible experts to conduct it shows how far a little hard work disciplined by the principles of scientific investigation can carry this fascinating, confusing, and often goofy subject.

Stringent Criteria of the First Kind

In one respect, the subject hasn't been carried very far at all. Some 33 years after Kenneth Arnold gave the world a space buzzword — "flying saucers" — when he reported seeing aerial discs, most sightings turn out to be something prosaic, leaving a residue of real unknowns in contention. This has done nothing to exorcise popular myths of extraterrestrial visitations, abductions on board alien spacecraft, or bodies of "little green men" secretly held in government vaults. Yet in the perspective of investigators trying to get an effective grip on a slippery subject, some important insights have been gained.

Besides Dr. Hynek, founder and scientific director of the Center for UFO Studies (CUFOS), there was Allan Hendry, CUFOS chief investigator; Bruce S. Maccabbee, navy physicist and chairman of the Fund for UFO Research; James E. Oberg, NASA engineer and author of *Omni*'s monthly UFO column; Robert Shaeffer, a UFO study veteran; and Philip J. Klass, a senior editor at *Aviation Week and Space Technology* who has taken on UFOs as a hobby. The latter three are also on the UFO subcommittees of the Committee for Scientific Investigation of Claims of the Paranormal.

Each emphasized that one major point emerging from three decades of UFO study is the consistent ratio of IFOs (identified flying objects) to true unknowns. Year after year, some 90 to 92 percent of UFOs reported worldwide can be explained in terms of natural or human effects when properly investigated. As Mr. Klass noted, this percentage is much higher than that of detectives solving local murders.

The second point is that the UFO sightings are a genuine grass-roots phenomenon — they are not a fad promoted primarily by cults of "true believers." In many different countries (including China, where the subject was taboo under Chairman Mao), people report the same sort of things year after year. Many of these observers have scientific or technical training; most are rational and honest. Although some sightings are hoaxes, there is a continuing worldwide tendency for ordinary people to see puzzling UFOs, nine out of ten of which turn out to have prosaic explanations. This presents a challenge to perceptual psychology, whatever the residue of unexplained UFO cases may or may not imply.

A third and major point, driven home by repeated hard experience, is the need for exceptionally stringent criteria as to what is acceptable evidence. Dr. Hendry, who has personally investigated over 200 sightings, found many cases where people misidentified ordinary objects such as advertising planes, describing them as dome-shaped spacecraft, for example. There is a prevalent myth of what UFOs should look like, and many people simply

report what they think they should have seen. Dr. Hendry proposes that to qualify for study, UFO sightings should occur in full daylight and have several independent witnesses. The sighted object should have an apparent angular size at least as large as the full moon so details are clearer. These requirements might eliminate many tantalizing cases, he said, but also would cut down on observer error. "If one searches hard enough," he noted, "such cases can be found."

The trend toward using hypnosis in investigations — now showing up in police work as well — would also be ruled out. Hypnosis has been used to help people free memory blocks and then, supposedly, to recall forgotten experiences. Dr. Hynek and others pointed out that this technique involves mental suggestion; subjects easily pick up clues from the hypnotist. Some of the cases of abduction by flying saucer have arisen through hypnosis, and even people who know they never had such an experience can be induced to tell as good a tale as any of the purported abductees. Asked if they believed abductee stories, the panelists all said they were not credible — they are just part of the "noise" that makes scientific UFO research difficult.

Stringent criteria would rule out the lurid close-encounter cases UFO buffs love, as well as most unexplained sightings, but they would also help put UFO study on a no-nonsense basis. In fact, there was so much agreement among the panelists on the need for a hard-nosed approach that one might wonder what they could argue about. It turns out to be the 10-percent residue of unexplained reports.

True Believers vs. the Null Hypothesis

Hard-core skeptics such as Mr. Klass and Dr. Shaeffer are ready to dismiss the unexplained cases, saying they would also have prosaic causes if better information were available or they could be investigated more thoroughly. Scientific procedure demands that an investigator opt for the simplest hypothesis to fit the data, Dr. Shaeffer said, adding that, in this case, the simplest hypothesis is the "null hypothesis." This statistical term means that the 90 percent of cases that are explained and the 10 percent unexplained are all from the same population — a set of events with prosaic causes.

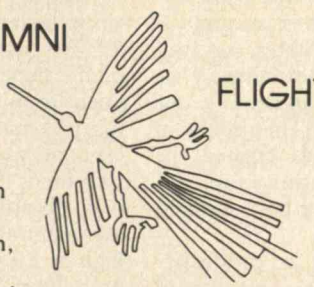
But other panelists aren't ready to buy that. They are "skeptical of extreme skepticism," as Dr. Maccabbee put it — they find enough challenge in the unknowns to warrant more study. Even Dr. Oberg, who said he doesn't believe UFOs have an extraordinary cause, called for an open-minded approach.

This is sensible, although the hype and nonsense of the UFO scene make it easy for the skeptical to relax with the "null hypothesis" and forget the whole business. Dr. Hynek, for all his earnestness in keeping his investigations on solid ground, has not been entirely helpful. In books, articles, and lectures, he has been prone to speculate about UFOs as manifestations of alternative realities, and to discuss possible meetings with alien beings in ways that give the impression that he leans toward being a "true believer." This has tended to undercut his long crusade to persuade the scientific community that the UFO phenomenon is worthy of study.

Aware that other panelists have criticized him on this point, Dr. Hynek explained that it is the UFO phenomenon that he considers worthy of study — the fact that people are seeing unexplained things. He is not pushing any particular theory to explain it. "Many usual things are seen under unusual circumstances," he said. "If seen by enough people, someone will interpret them as UFOs. But not all UFO reports necessarily result from natural or human causes."

There is nothing to quarrel with in that statement. And when it comes right down to it, there isn't that much disagreement between Dr. Hynek at one end of the spectrum and Mr. Klass at the other. And even Mr. Klass and Dr. Shaeffer, for all their love of the "null hypothesis," could agree with the other panelists that the research should go on. What they did plead for was to be allowed to get on with it in peace, with less distraction from the news media playing up every spurious sighting or sensational encounter story. They have a point — I wish them well. But after 30 years of covering the UFO story and struggling to keep just one newspaper "honest," I hope they don't expect too much self-discipline from the press. □

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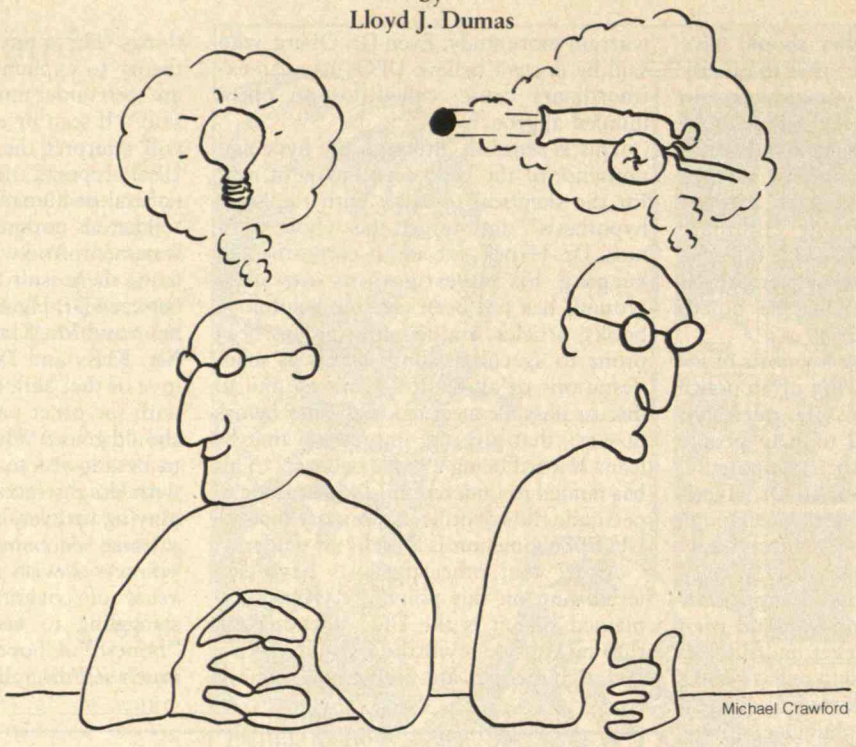
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Innovation Under Siege

by
Lloyd J. Dumas



The sorry state of commercial innovation in the United States, so well documented and widely discussed, has played a critical role in generating our current economic malaise. The decline in commercial innovation has created the simultaneous high inflation and unemployment from which we have suffered since 1969.

Lacking a steady stream of productivity-enhancing innovations, firms faced with rising costs of fuels, labor, and materials have been compelled to pass these costs along to consumers in the form of higher prices — a powerful inflationary mechanism. Furthermore, rising prices and deteriorating relative quality have made U.S.-produced goods increasingly noncompetitive in both world and domestic markets, forcing production cutbacks and plant closures in the U.S. and creating additional inflationary pressure. Thus, innovation, unemployment, and inflation are linked.

But what has produced the decline in commercial innovation? Is the problem, as *Business Week* diagnosed in 1976, that "the country's genius for invention is not what it used to be"? There is no failure of technological innovation here; our "genius for invention" has not disappeared. Instead, we have a massive distortion of our technological development.

Over the past 30 years — particularly since the launching of Sputnik in October 1957 — we have diverted a large portion of the nation's scientific and engineering talent to military-related pursuits (including the space program). It is difficult to estimate accurately just how large this portion is because of various forms of data obfuscation, but it is probably not less than 30 percent and perhaps even as high as 50 percent. This heavy emphasis on military-related research has predictably generated a sharp increase in the rate of military technological development — and just as predictably, a decline in the rate of commercial innovation.

The Lion's Share

How has the government channeled this talent into noncivilian areas? First, by letting the Department of Defense (DOD) award the lion's share of federal grants. As of 1974, according to National Science Foundation (NSF) data, more than half of the nation's engineers and scientists with federal grant support received it from the DOD.

Furthermore, the DOD is not the only branch of the government that funds military research and development or even military production. For example, facilities such as the Lawrence Livermore Laboratory in California, which designs and develops nuclear weapons, and the Rocky Flats Plant in Colorado, which manufactures plutonium triggers for such weapons, are formally the responsibility of the Department of Energy.

When we add to the DOD funds the grants from other federal agencies involved in activities with close military applications, the fraction of researchers receiving such support increases to three-quarters. Indeed, NSF data for 1974 show that nearly two-thirds of federal grants went to support military-related research and development.

The multibillion-dollar sums spent by the DOD — currently over $50 billion per year for weapons procurement, including the substantial underlying R&D costs — attract yet more engineers and scientists into defense-related work at military-industrial firms. Because cost recovery is essentially guaranteed by the contracting system, such firms can offer the high salaries that will attract top-notch technologists. There may well be additional attractions, such as the prestige associated with working at the cutting edge of technology and the relatively loose cost constraints on research and design.

Surely, it could be objected, large commercial industrial corporations can afford to pay engineers and scientists salaries competitive with those they now receive in the military sector. While that may be strictly true, it is essentially irrelevant. Pri-

vate firms must sell their products in the marketplace, not through negotiated contracts to government agencies with roughly half the annual federal income-tax revenues at their disposal. Accordingly, private firms must pay close attention to cost. Even though they may well be able to "afford" to pay more, they may not find it worthwhile to do so, particularly if they are caught in the increasingly common trap of focusing on short-term returns on investment. Furthermore, if private firms offered salaries high enough to draw significant numbers of technologists back into the civilian sector, the government would simply up the ante. And nothing would have been accomplished save another escalation of cost.

In the face of large-scale diversion of engineering and scientific talent into military-related activities, the only way to avoid massive technological distortion is through the much-vaunted "spinoff" or "spillover" of military technology to the commercial sector. In a 1974 report, however, a committee of the National Academy of Engineering stated that "with a few exceptions, the vast technology developed by federally funded programs since World War II has not resulted in widespread 'spinoffs' of secondary or additional applications of practical products, processes, and services. . . ."

It is difficult to imagine that by directing technical research at a specific set of goals, we could routinely and efficiently generate knowledge pertaining to a completely different set of goals. In fact, if the spinoff phenomenon were significant, it is hard to see how civilian technology could have become so anemic.

Priorities and Political Will

For basically ideological reasons, most economists have been blind to the crucial role of military expenditures in generating stagflation. The two prevailing macroeconomic theories, Keynesian and monetarist, focus on the size and short-term effects of monetary aggregates (total demand in Keynesian theory and the money supply in monetarist theory).

On the other hand, this phenomenon concerns the distribution, not merely the size, of spending and its effects on the allocation of resources. Clearly, the level of military spending in any one or even several years has not caused the problem, but rather the persistence of high military expenditures over several decades. Technological leads do not disappear overnight, but neither do they persevere in the face of many years of relative neglect.

Given that this accurately portrays the essence, if not the totality, of our present situation, powerful policy implications follow. The most obvious is that the machinations of traditional fiscal and monetary policies — tax cuts or increases, manipulations of interest rates, and the like — cannot hope to bring more than temporary, cosmetic relief to the economy so long as our national defense policy locks a large fraction of the nation's technologists into nonproductive military work. Until there is a serious national commitment to move a substantial fraction of the military technological work force back into civilian-oriented activity, the debilitation of the U.S. economy will continue. In fact, since the debilitation is cumulative, it will no doubt worsen.

Transferring technological resources from military to civilian activity is not a trivial matter. Military design emphasizes product performance with relatively little attention to cost factors. Civilian technological development, on the other hand, demands that product quality be

Continued on page 76



Lloyd J. Dumas is associate professor of political economy at the University of Texas at Dallas. He was recently appointed a member of the Steering Committee on Nuclear Weapons Control of the American Association for the Advancement of Science and has helped to draft economic conversion legislation.

Born-Again Innovation

The Defense Economic Adjustment Act (bill number S.1031), introduced by Senators George McGovern and Charles Mathias, is designed to provide help for scientific and technical workers to convert from military-related projects to the civilian sector. The bill involves localized, people-oriented, low-bureaucracy conversion planning, and so is unique among such legislative proposals.

The bill requires that alternative-use committees representing labor, management, and the community be established at every military base and military-industrial facility. These local committees would be funded independently and have complete control over conversion plans for their facility. The diverse interests of each group would insure a serious planning effort.

The local alternative-use committees would have access to all information at the facility. They would also be supplied with the *Conversion Guidelines Handbook* produced by a national Defense Economic Adjustment Council.

This national council (consisting of cabinet members, representatives of nondefense business, and labor unions) would serve mainly to encourage civilian projects at the federal, state, and local levels to create new and expanded markets for converted defense contractors. It would also serve as an information coordinator. The council could give advice but would have no authority to enforce it.

When a facility actually underwent a major cut in defense contracts, the conversion plan would be put into effect and workers would be retrained for civilian operation. During the period of changeover, they would be eligible for income support equal to 90 percent of their first $20,000 and 50 percent of the next $5,000 of their previous income, and continuation of medical coverage, pension, and other benefits for up to two years. Those not employed at the converted facility would be given reemployment assistance and relocation allowances. No subsidies would be given to employers.

The money to finance worker benefits would come from a pooled fund into which every defense contractor would be required to pay 1.25 percent of its total military sales revenue (not profits — this avoids profit manipulation).

This bill would not provide for cuts in the military budget, but it would create a vital system of advanced planning to prevent even interim job loss and economic suffering of people and communities. — *L.J.D.* □



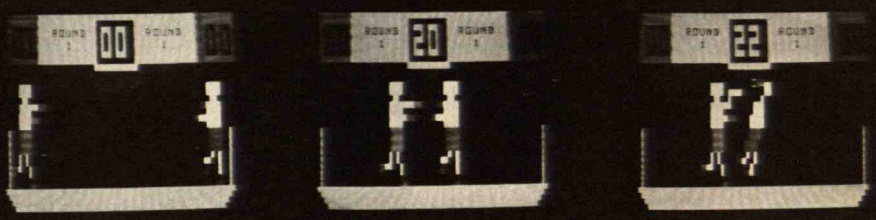
Games People Program

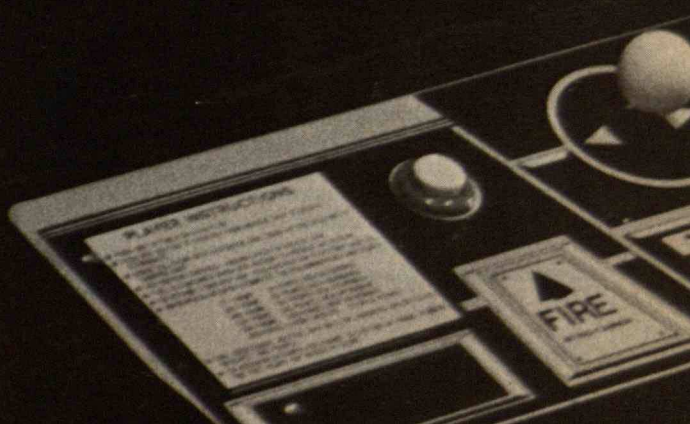
by
Ellen Ruppel Shell

It's long past midnight, but the lights in the neighborhood recreation center are still burning brightly. Clumps of young people huddle around gaudy plastic boxes, their glazed eyes fixed on the pulsating screens. Dates, beer blasts, and other Friday-night frivolities forgotten, the pale but otherwise vigorous throng labors on. Their goal – to knock out as many alien invaders as possible before their supply of quarters runs out.

Computer games — the biggest scourge to student romance since the final exam — have caught on and how. No longer the exclusive playthings of "computer hackers" (those notoriously compulsive science and engineering majors known for wedging in quick games of Star Trek between problem sets), electronic games are today threatening to outdo even pinball's hold on the collective imagination.

While various versions of tic-tac-toe



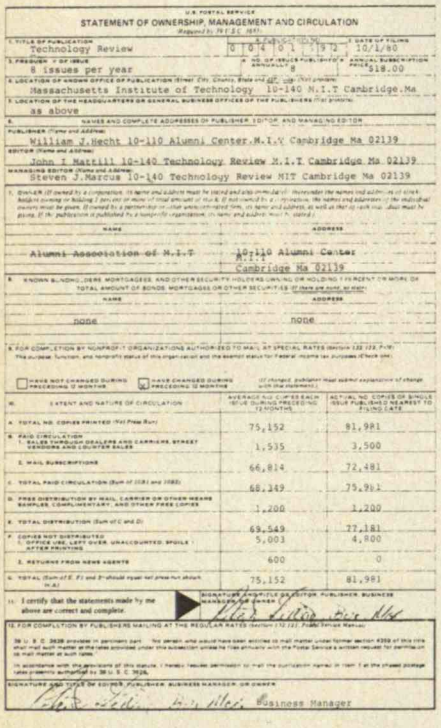




Photos: Chris Maynard

have been played on computer terminals for nearly a quarter-century, computer expert David Ahl, publisher of *Creative Computing* magazine and a veteran game designer, recalls that the first "really exciting game" was developed by students at M.I.T. in the 1960s. Called "Space War," this action-packed pastime enjoyed an enthusiastic but limited following because, until recently, the high-resolution graphics it required were available only on large, sophisticated computer systems. The general public had to wait for its first real exposure to space-age recreation until the mid-1970s, when Nolan Bushnell, an engineer-turned-entrepreneur, decided to risk his assets in the penny-arcade business.

Bushnell may well be the person most responsible for the popularization of what is known as the "first generation" of computer games — machines designed to perform a single function very quickly and very well. Tinkering in the garage of his California home, he captured the essence of M.I.T.'s Space War in a self-contained coin-operated device. After several modifications, "Pong" was born — an electronic Ping-Pong game that has become virtually a fixture in bus stations, bars, and student hangouts nationwide. Atari, the company Bushnell built around these electronic arcade games, was sold in



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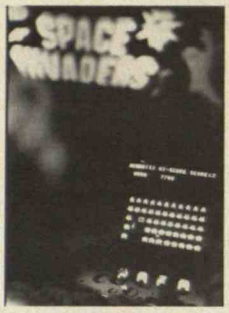
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1976 to Warner Communications. And while Warner keeps its sales figures a secret, it is known that Atari grossed $39,000,000 the year Bushnell sold it. Today the most popular game Atari markets is "Space Invaders," a space-age war simulation that involves, among other things, the zapping of hostile alien creatures with death rays. Originally designed by Japanese programmers, the game is so addictive that the Japan mint ran short of the 100-yen coins used to prime its sensors.

Advances in silicon-chip technology during the late 1960s swept away the obstacles of cost and bulk that had kept computer games from invading the home market. Using integrated circuits — tiny slices of pure silicon embedded with traces of impurities — engineers condensed the functions of a roomful of vacuum-tube equipment into a portable plastic box. By the late 1970s, it was possible to purchase a personal "Pong" to hook up to your televison when the reruns ran sour.

Other computer sports simulations as well as a boggling array of Star Trek spinoffs followed, but because each video unit was programmed to serve up at most only three or four variations on a single theme, it wasn't long before even the best were consigned to the dusty depths of owners' attics.

The next step was to design a unit capable of playing a wide variety of games with more variables, more visuals, and more enduring appeal. The solution was to create sophisticated "programmable" machines — consoles into which one could plug a selection of "software packages," or programs. Matell, the toy manufacturing giant, recently introduced one such second-generation model called Intellivision, which allows users to play checkers, roulette, football, and a variety of other games at the flick of a software switch. But even this elaborate $300 machine does not encourage much user manipulation. Players simply pop in a cartridge and play away; they can do nothing to alter the basic program burned into the "read-only memory" (ROM) tape cassettes. ROM cartridges cannot be copied or altered, a big plus for manufacturers worried about having their software "stolen" — copied onto blank tapes. But like the microprocessor in a microwave oven or fancy sewing machine, ROM programs are designed to do one thing only, and therefore lack interest for students or hobbyists eager to discover and explore programming techniques.

Beyond Flitching and Twitching

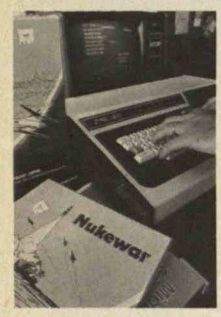
More recent developments in electronic playthings challenge users to create as well as to conquer. The home or "personal" computers, complete with keyboard and expandable memory banks, encourage players to program their own games, as well as give them access to a wide variety of highly imaginative and complex program packages.

Like ham radios, home computers were first available in kits. But in 1977, Processor Technology decided to market its Sol-20 computer already assembled, and almost overnight personal computers leapt out of the hobbyist's closet and into the living rooms of middle America.



Today's home computer market is dominated by four highly competitive companies — Radio Shack, Apple, Commodore, and the ubiquitous Atari. Each makes a product with, as David Ahl says, its own "special flavor," but all models are capable of, among other things, playing games. Users can buy their games packaged on ready-to-use tapes or "floppy disks" — circles of flexible Mylar plastic that record programs much like tapes but allow easier access — or they can program their own games using books or their own imaginations. There are a number of software "publishers" who design and

market game programs for home use, and while most of these are of the "zap-the-alien" genre, some, like those distributed by Scott Adams' "Adventures International" software, involve a variety of imaginative and even thought-provoking effects.



Like most serious computer specialists, Adams believes that electronic games can and should be more than what one detractor dubbed "flitching and twitching exercises." His Florida-based company distributes nine different packages featuring "thinking games," requiring players to use logic, strategy, and common-sense in their pursuit of some predefined goal. One particularly intriguing Adventures International game involves what is known as "interactive fiction," in which players become part of an unfolding adventure story and have a say in the outcome. For example, a user may be instructed to stroll through the streets of a frontier town, only to stumble upon a gunfight. The player may then choose either to outlaw the use of weapons, thereby wiping out the gunfight option in future interactions, or to enter wholeheartedly into the fray. Other programs challenge users to reconstruct history by, for example, taking a silicon-sponsored trip back to Waterloo and altering Napoleon's military game plan.

Personal computers and the games people play on them are quickly becoming an integral component of our recreational arsenal. The *Wall Street Journal* reported earlier this year that a total of 600,000 home models were in use. A British company, Science of Cambridge, Ltd., promises to broaden the market still further this Christmas with its Sinclair ZX-80 "complete personal computer system," a 12-ounce cassette-recorder-size device that, with its incredible $200 price tag, could well replace the portable radio in the bookbags of well-heeled adolescents.

Chips in the Toy Box

How much of an impact will these increasingly common machines have on our sensibilities? Sherry Turkle, associate professor of sociology in the M.I.T. Science, Technology, and Society Program, has studied closely the effect of "high-tech rec" on its most faithful followers, the young. "Toys affect the basic philosophical categories in which children will interact for the rest of their lives," Professor Turkle says. "The world used to be divided into the animate and the inanimate, but with the coming of the computer, this is no longer so. Interactiveness, the criterion by which children decide what is and isn't alive, is no longer an appropriate indicator because computers cut across that distinction."

Professor Turkle's studies show that the impact of computer playthings depends on the personality of the child and the context in which the toy is used. For example, a youngster whose life is confused or directionless may find solace in the control and independence the computer world offers. However, some children become so absorbed in the electronic abstractions that they withdraw completely.

"Computer toys and games are neither good nor bad, but they are powerful," Professor Turkle warns. "You can use them to create, change, manipulate, and control your immediate environment. This can be dangerous when a child finds relationships with the computer more fulfilling than relationships with people."

Professor Turkle suggests that parents acquaint themselves with a computer game or toy to determine whether it will enhance their child's development or simply act as a diversion. Parents who think they can sidestep the whole issue by investing in Flexible Fliers instead of Ataris or Apples this Christmas are only postponing the inevitable, she cautions. It is almost certain that all but the most isolated youngsters will stumble across some sort of electronic "thinking" machine between home, school, and playground.

Says Professor Turkle: "Literate adults should start thinking about what kinds of computations are most fulfilling for their children, because computers are going to become an increasingly important part of everyone's life." □

Ellen Ruppel Shell is a staff editor at Technology Review.

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History Unraveled

A Golden Thread: 2,500 Years of Solar Architecture and Technology
Ken Butti and John Perlin
Palo Alto: Chesire Books/Van Nostrand Reinhold, 1980, 289 pp., $15.95

Reviewed by Charles G. Wing


Jon McIntosh

When I was an undergraduate memorizing physics formulas such as Poiselle's equation for the friction of fluid flow in a pipe, I often wondered how some of my classmates justified studying history. "One studies the past to help civilization avoid repeating its mistakes" was the most common defense. Another was: "History provides perspective; the future is never as dark as painted by the cynics nor as bright as claimed by the optimists." From my perspective, neither of these claims rang true. Why, if historians had been doing their job, had we continued to go to war over the same issues? Historians, it seemed, simply preferred digging through old manuscripts to digging ditches, or cataloging names and dates rather than automotive parts.

Well folks, I have been proven wrong. At precisely the moment when I and most others in the field of solar energy are in need of perspective, along come Ken Butti and John Perlin with an amazing documentation of the human love affair with solar energy. Before I relate the wonders of their book, however, let me explain why it is such a timely one.

I left the fields of physics and oceanography after a brief career that, while professionally rewarding, was personally unsatisfying. Like many other students in the 1960s, I couldn't integrate the wonderful orderliness and success of the technical world with the obvious untidyness of the real world. I left Boston to return to a childhood memory of order and happiness: Maine. But what could a person trained in the physical sciences do in Maine? Well, one thing it seemed obvious he *couldn't* do was practice physics.

Like a compost pile, physics requires a critical mass of (intellectual) activity to sustain it. I obtained a position teaching physics at my alma mater, Bowdoin College, but physics existed there, as at most small colleges, as a sort of exotic hothouse plant in a hostile environment. This arrangement did nothing to assuage my sense of estrangement from the real world; in fact, things got worse. An encounter I had soon after making the move illustrates the situation. I had purchased an old run-down farm in nearby Woolwich. Anxious to be accepted by the neighbors (being born in Maine is no guarantee of acceptance once one has left the state for more than a weekend), I dropped in on the nearest one, a genteel lady in her seventies who, incidentally, still cuts her own firewood. Intent on impressing her, I told her that I had just left M.I.T. and was teaching physics at Bowdoin.

"M.I.T.? Where's that?" she asked.

"Massachusetts," I answered, apparently successfully.

"Physics? What's that for?" came next.

Try as I might, I could not define physics in a way that was meaningful for her. That question, so innocently posed, exposed the heart of my dilemma! Physics, what's that for? What good is it? How does it help with life's basic physical requirements: food, clothing, and shelter? Shelter, especially, I could relate to. My old farmhouse was too cold in winter, too hot in summer. Why, I couldn't even keep a candle lit on the kitchen table when the wind started to blow. My barn sills were gone; I, with seven years of training in physics, couldn't figure out how to replace them. My truck needed new piston rings; the only physics that came to mind when contemplating the disassembled engine was the concept of entropy. It suddenly became clear that there was plenty of room for appropriate technology here.

Solar Can Be Fun

Overnight my consuming passion became physics as applied to the world around me, most particularly, energy consumption of my house. Never jaundiced by formal training in aesthetics, my eye saw right past balance, proportion, and dramatic use of space to the house as a physical system: I perceived a total disaster.

I was not alone. Like the desert flowering after the once-in-a-decade rain, individuals and groups across the country sprang up after the 1973 energy crisis proclaiming a new vision: conservation and solar energy. And was it fun! First came the newspapers, then the books (remember the hundreds of books on solar this and solar that in the home-repair sec-

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tion of the paperback bookstores?), and then the energy fairs and the magazines.

We were heroes! The little people, the backyard inventors, were going to inherit the earth. Time was clearly running out for the utilities and the oil companies.

Several months ago I attended a conference at Princeton on solar energy and retrofitting, sponsored by the Mid-Atlantic Solar Energy Association. Something happened there that upset my view of the world. I was sitting in an audience of solar and conservation professionals from private companies, federal and state energy offices, utilities, and educational institutions, listening to a panel consisting of individuals who had played leading, if sometimes eccentric, roles in the solar movement of the 1970s. The discussion turned to the proper role of government in promoting solar energy and energy conservation. I was sitting next to a woman who held a key position in a state energy office, someone who perhaps arrived late in the game but who plays the solar advocacy position as passionately as any of the original team members.

What followed from this select panel of solar pioneers was such a venting of hostility toward government, utilities, and industry that I dared not look at the poor woman. Later, I learned that she had the same fear of me. Incredibly, after years of calling for federal and state energy conservation and solar tax credits, and for federal support of solar research and development, just as these things had come to pass, the panel was angry that it had happened! What was the missing link?

Continuing the Thread of History

Enter Butti and Perlin. I had met Ken Butti a month before at the Frankfort (Indiana) Community Library Energy Fair. (I swear, it's the truth!) I and 500 other members of the solar movement had listened, mouths agape, as Ken documented with slide after slide the incredible history of solar energy. Watergate came as no greater surprise than the descriptions of attached solar greenhouses, solar baths, thermal mass, solar porticos, solar-rights legislation, solar cities — all of which existed several thousand years ago! Butti also mentioned the more recent well-developed passive solar building industry nipped in the bud in the 1940s by the aggressive marketing of cheap oil. Even more amazing was the fact that solar energy had been "discovered" at least five times by different societies in separate parts of the world. I had always wondered how the human mind, capable of developing the atomic bomb and the computer, could have overlooked the simple facts of solar energy: that the sun beams energy at the earth from high in the sky in summer and low in the sky in winter, and that by application of simple geometric and physical principles, solar energy could be used to temper buildings. According to Butti and Perlin:

☐ Humans discover solar energy every time fuel becomes scarce and expensive.

☐ Humans forget solar energy every time a new source of cheap energy is developed.

☐ Individuals linked to solar movements tend to be eccentric, egotistical, and proselytizing.

☐ Whenever a solar movement gains acceptance, the larger power brokers (such as government and industry) move in and take over.

I just happened to be carrying *A Golden Thread* in my suitcase at Princeton. On the way home, I devoured it. Richly illustrated and thoroughly documented, it was a feast for the most critical historian's mind and eye: the Roman Emperor Tiberius and his hothouse cucumbers; Fatio de Duillier's proposal for a sun-tracking grape-growing mechanism for the English gentry; James Anderson's patented 1803 solar greenhouse with heat storage, double-glazing, and nighttime window insulation; Mouchot's Augustin sun machine that drove a one-half-horsepower motor, distilled brandy, baked bread, and made ice in the Sahara. The book also described in detail American entrepreneur Frank Shuman's 1914 plan to build 20,250 square miles of solar collectors in the Sahara to replace coal mining; the 60,000 solar water heaters sold in Florida between 1935 and 1941; even prefabricated passive solar homes. Everything fell into place — we were and are but a continuing thread of history.

Reordering of Society

Perhaps the select panel at Princeton was angry because they sensed the end of the party. It's no fun to pull a tiger's tail if it growls back. How can one fault a government that passes a 40-percent solar tax credit, utilities that offer customers low-cost residential energy audits, oil companies that sell solar water heaters? You can fault their motives, perhaps, but you cannot deny that solar energy has arrived. The solar innovators have achieved, in fact, one-half of what they set out to do — make solar energy viable.

What they have failed to achieve so far is the reordering of society crucial to the decentralization of power. But now, thanks to Butti and Perlin, we have the advantage of historical perspective.

Charles G. Wing, founder of Cornerstones, the "school for energy-efficient housing," holds a doctoral degree in oceanography from M.I.T. He is author of From the Ground Up *(Little, Brown, 1976).* ☐

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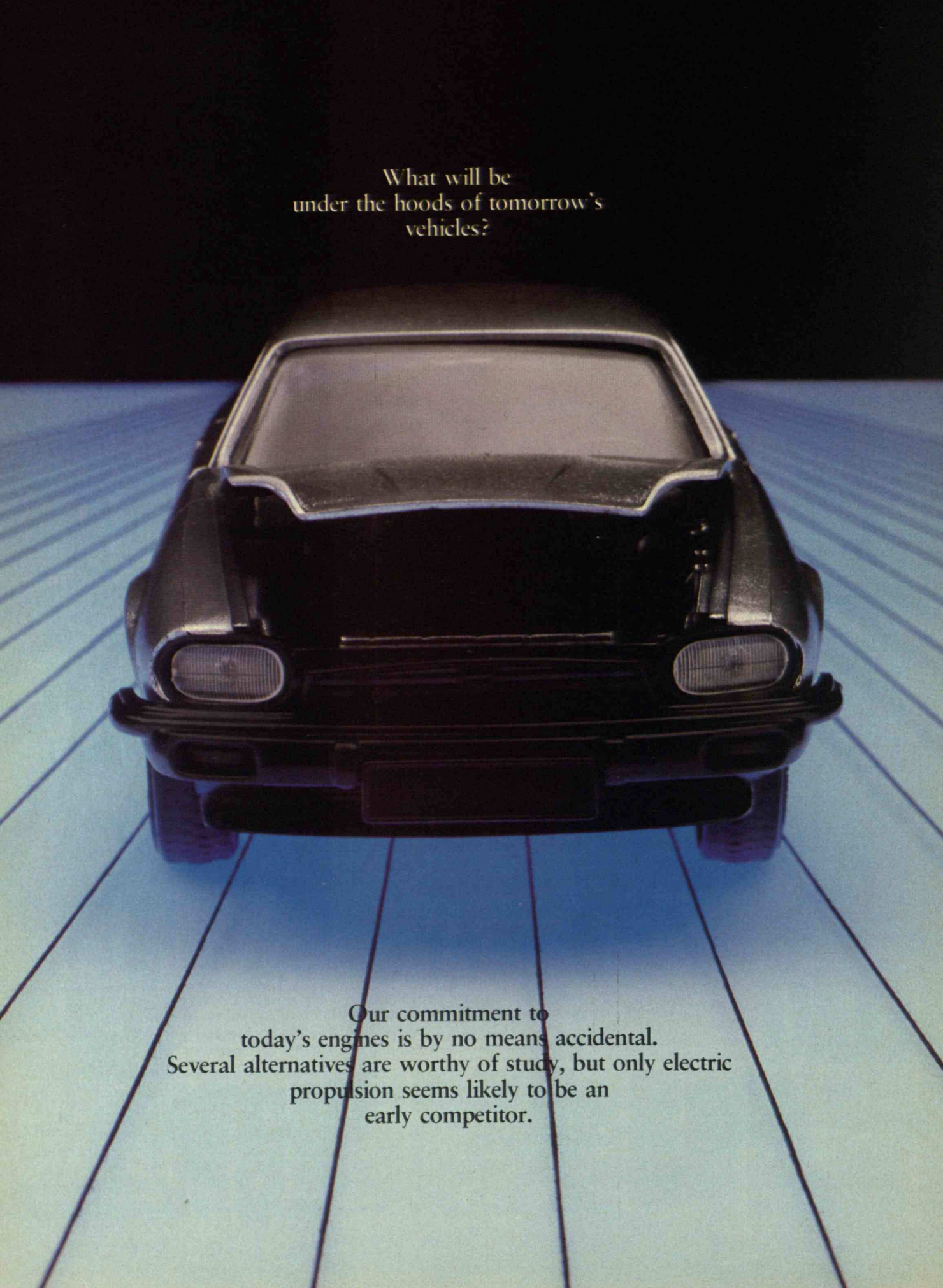
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Several alternatives are worthy of study, but only electric
propulsion seems likely to be an
early competitor.

Is There a Better Automobile Engine?

by John Heywood and John Wilkes

An unprecedented effort in engineering science and automotive technology — a $75-billion program in research, development, and retooling — is now being mounted by the auto industry to make the fuel efficiency and costs of its products appropriate to the needs of the 1980s. Much effort will be devoted to changes and improvements in vehicle design; however, a substantial part of this prodigious new investment will go to research and development on propulsion systems. Much of this will be devoted to improving the familiar spark-ignition (gasoline) and diesel engines of today's automobiles, but some will also be applied to less familiar automobile power plants.

In addition to this massive industry effort, a new government-industry joint venture in auto-related research, the Cooperative Automotive Research Program (CARP), is now being initiated by the Department of Transportation, the National Science Foundation, and five U.S. auto manufacturers. Later to be supported by other federal agencies, CARP will devote up to $100 million a year to fundamental studies in combustion, thermal and fluid sciences, structural mechanics, electrochemistry, material sciences, and other fields relevant to automotive efficiency.

Does all this mean that breakthroughs are imminent? Will we soon see passenger cars powered by alternative engines in dealers' showrooms? No radical changes can come immediately, and none may in fact materialize, but evolutionary change is already rapidly occurring.

For example, as the media regularly report, remarkable fuel efficiencies are being wrung from internal-combustion engines. A group of Dutch students recently built a cigar-shaped shell mounted on four bicycle wheels, powered by a specially prepared 50-cubic-centimeter moped engine, that ran for 2,070 miles on a gallon of gasoline. The excellent fuel economy of the diesel is well known, so it is not surprising that Volkswagen has been able to build a diesel Rabbit that can carry five passengers in relative comfort, survive a 40-mile-per-hour barrier crash without injury to the occupants, and average 60 miles on a gallon of fuel in tests conducted by the Environmental Protection Agency (EPA).

The message in these achievements is that although the conventional spark-ignition and diesel engines have been around for a long time, there is considerable potential for further development. Improved fuel economy is being sought in the gasoline engine through on-board computers, changes in combustion chamber shape, improved emissions controls, higher compression ratios (with spark advance controlled electronically to avoid knock), and reduced engine size and weight through use of turbochargers, changes in engine design, and the use of new materials.

The engines that have dominated the automobile industry for so long will continue to do so at least through the 1980s . . .

Diesels will benefit from similar improvements. The prechamber diesel in automobiles is already about 25 percent more efficient than the spark-ignition engine. The advantage is due to the greater stored energy of diesel fuel and the higher thermodynamic efficiency of the diesel cycle.

In addition to these spark-ignition and diesel engine improvements, current development and engineering work will create a more optimal total system — involving engine, transmission, and vehicle. A realistic estimate of the long-term potential is that automobiles could gain up to nearly 50 percent in fuel economy from improvements of from 10 to 15 percent in each of these areas.

The need to conserve fuel because of increasing prices and uncertain availability is not the only fuel-related problem the industry faces. Additional uncertainty arises because fuel quality could begin to deteriorate significantly in the mid-1980s. The liquid hydrocarbons from which future gasoline and diesel fuel will be made, whether petroleum in the shorter term or oil from shale, coal, or tar sands in the longer term, are likely to contain increasing quantities of impurities such as sulphur and nitrogen; some of these may also appear in the refined motor fuel. Furthermore, there will be pressure to reduce the octane rating of gasoline to increase the yield from crude oil and to reduce the energy used in refining. (Using fuel with too low an octane rating causes the familiar knock or "ping" signaling spontaneous ignition in spark-ignition engines.)

Diesels also require high-quality fuel. Since the fuel is ignited spontaneously as it is injected into the hot compressed air in the combustion chamber, its ignition quality (defined by a cetane number) must be carefully controlled. Fuel with too low a cetane rating results in poor control of the combustion process, excessively high pressure in the combustion chamber, high stress levels, increased noise, and difficult starting. Also, poorer fuel quality would probably mean higher particulate emissions. Diesel particulates have been shown to cause mutations in human cells — an effect linked to cancer — and indeed some believe that unless its emissions can be better controlled, the diesel is in danger of being legislated out of existence.

In view of the increasing price and prospect of declining quality of fuel, are spark-ignition and diesel engines, the choices of today, the best alternatives for the future? Should we turn by the late 1980s and 1990s to engines with less demanding fuel requirements? Is there a significant trade-off between an engine's efficiency and fuel requirements and the energy needed to process its fuel?

These issues are extraordinarily complex. The several unconventional propulsion systems now under consideration have widely varying characteristics, and all are much less developed than the two established passenger car engines. Many attributes of an engine must be evaluated before it can be assessed in the context of a particular vehicle, and many years of development are required before decisions about large-scale applications can be made. The engines that have dominated the auto industry for so long will clearly continue to do so at least through the new decade, and probably into the 1990s. Fortunately, there remains substantial potential for improvement. Because of the massive engineering resources behind the well-established engines, they will steadily be made better and better.

Within ten years, however, the picture may well begin to change, with a wider variety of automotive power systems attracting attention. What are the salient characteristics of each of these options, and under what conditions are they likely to be competitive with the ever-improving spark-ignition and prechamber diesel engines?

The Stratified-Charge Engine: Easier to Fuel

Ever since the 1920s, attempts have been made to develop a hybrid internal-combustion engine that combines the best features of spark-ignition and diesel engines. The goals have been to operate such an engine at close to the optimal compression ratio for efficiency (in the range of 12:1 to 15:1), to inject the fuel directly into the combustion chamber just before combustion, to ignite the fuel with a spark plug to control the ignition process directly, and to change the power level by varying the amount of fuel injected per cycle while keeping the air flow almost unthrottled to minimize pumping losses. This arrangement promises both higher efficiency and good emissions control. Direct injection of fuel makes possible the staged ignition of a rapidly swirling, "stratified" fuel-air mixture that is rich near the spark plug electrode and becomes increasingly lean near the periphery of the combustion chamber. The overall air-fuel ratio of such a stratified-charge engine is considerably higher (i.e., the mixture is

. . . But the massive engineering resources behind these well-established engines assure that they will be steadily made better and better.

leaner) than in a conventional gasoline engine, the major reason its efficiency approaches that of the diesel.

Ford and Texaco are currently testing engines based on this concept. The Ford PROCO (an acronym for "programmed combustion") engine is closer to the conventional spark-ignition engine than the diesel and operates at compression ratios of about 11:1 with regular (unleaded) gasoline. Because injection occurs relatively early in the compression stroke, the air-fuel charge is well mixed before ignition. Combustion is fast, which permits a substantial percentage of the exhaust gas to be recirculated to reduce combustion temperatures and consequently emission of nitrogen oxides (NO_x). Yet temperatures are sufficiently high to permit afterburning of carbon monoxide (CO) and hydrocarbons (HC) in the exhaust manifold and catalyst, significantly reducing those emissions. The PROCO runs efficiently — fuel consumption is roughly equivalent to that of a prechamber diesel. A disadvantage of the PROCO is that its early injection and consequent superior mixing of the air-fuel charge can lead to knock, so gasoline of normal octane rating is needed. Also, the need to control power by throttling as in the conventional spark-ignition engine results in a loss of work as air is pumped into and out of the system.

The Texaco controlled-combustion system (TCCS) is almost a direct-injection diesel engine with spark ignition. Fuel is injected immediately before the piston reaches the end of its compression stroke, so, in contrast to the conventional spark-ignition engine, knock is not a problem. And because a spark ignites the charge, no minimum fuel-ignition quality is required, a drawback of the diesel. Also unlike the diesel, cold starting is not a problem with the TCCS, so the compression ratio can be in the optimum range of between 13:1 and 15:1. The TCCS, therefore, can operate with any distillate fuel, a substantial advantage if fuel quality declines. The main disadvantage of the TCCS is that its late injection allows less-than-optimal mixing of fuel and air, resulting in the emission of more particulates than the PROCO. Furthermore, there appears to be a trade-off between fuel quality and levels of HC and CO emissions: the lower the fuel quality, the higher these emissions.

The PROCO, which has benefited from substantially more resources for research and development than the TCCS, is close to the point where a decision to prepare for large-scale production could be made. The Texaco concept is currently being fleet-tested by the U.S. Postal Service in a White Engines, Inc., design. Fuel economy comparable to equivalent diesel vehicles is apparently being achieved.

The Direct-Injection Diesel: Top Efficiency

The standard automotive diesel utilizes a precombustion chamber to create turbulence in the air charge to promote rapid mixing with the fuel jet and therefore obtain complete combustion, and to reduce smoke emissions. Though this engine has been in production for several years, it has potential for improvement. Prospects for development of the prechamber diesel hinge on improving combustion chamber design to reduce losses that result from flow between the main combustion chamber and the prechamber, and to reduce the formation of pollutants. The timing and duration of fuel injection can then be optimized to give higher fuel economy within emissions constraints. Improved torque characteristics achieved through turbocharging and internal design modifications will make possible smaller, lighter engines, and ceramic materials now under development may lead to further improvement in thermodynamic efficiency.

Two efficiency penalties of the prechamber diesel engine are resolved in the so-called direct-injection diesel: the heat loss through the additional surface area required by the prechamber, and the pumping losses in generating enough turbulence between the prechamber and combustion chamber to mix the air charge with the injected fuel during combustion. There is no prechamber in the direct-injection engine; fuel is injected into the clearance volume as the piston approaches its top position. The direct-injection diesel has long been the standard configuration for intermediate-size and heavy-duty engines; now several firms are known to be developing small direct-injection diesel engines for passenger cars. Fiat, for example, has a prototype for which it claims a 10-percent improvement in fuel economy over similar-sized prechamber diesels as well as lower particulate emissions. On the other hand, emissions of nitric oxides are higher because of the higher combustion temperatures. While few data on direct-injection diesels have been published, informal reports of fuel economy gains over the prechamber diesel make the direct-injection diesel a promising near-term option.

Without ceramic rotating components, we rank the gas turbine as a long-odds outsider in the race for the future passenger-car engine.

The Gas Turbine: In Need of a Breakthrough

The potential attractiveness of the gas turbine as an automotive power plant is based on several characteristics: its few moving parts; potential for higher power per pound of engine weight than offered by existing conventional engines; vibration-free power delivery (a consequence of rotary work processes); low emissions owing to its isolated, continuous, and more easily controlled combustion process; easy cold starting; potentially longer life and low maintenance requirements; and multifuel capacity. Weighing against these advantages are the relatively exotic and costly material and manufacturing requirements of the gas turbine, and the fact that the turbine operates best at constant speed, a characteristic difficult to match to the highly variable speed demands of an automobile. The speed problem can be handled most efficiently by a continuously variable transmission, and prototypes of such a device are under development. Though the gas turbine has potential for high efficiency, high-temperature ceramic components are essential if it is to be competitive as a passenger car engine. Such components in all high-temperature running areas would make possible greatly increased turbine inlet temperatures (1,400°C and more) with attendant benefits in power density, fuel economy, and weight reduction.

The gas turbine is one of two targets of a substantial Department of Energy (DOE) program aimed at developing advanced alternative automobile engines. The program has focused on an upgraded version of the turbine, which Chrysler has developed since 1938 and intensively in the early 1960s. Now contracts for advanced system design studies and prototype development have also been awarded to Williams Research Corp./AM General, Detroit Diesel Allison/Pontiac, and Ford Motor Co./AI Research. The goal of the DOE program is to have, by 1985, a turbine-powered, 3,000-pound demonstration vehicle capable of achieving 42.5 miles per gallon using a variety of alternative fuels while meeting all emissions standards. General Motors has already developed a passenger-car turbine that meets the long-term U.S. emissions standards, including the 0.4-gram-per-mile NO_x research goal, but fuel economy and driveability do not yet equal those of the existing conventional engines. Improved variable geometry of all the flow-controlling elements of the engine should make possible improved part-load efficiency in the near future, currently a weakness of the gas turbine. Better ceramics for hot stationary and rotating parts are also steadily being developed, promising greater engine life. Indeed, rotors have been tested at 1,000°C for over 4,000 hours without failure, and one successfully completed a 200-hour durability test at temperatures up to 1,150°C and speeds up to 50,000 rpm.

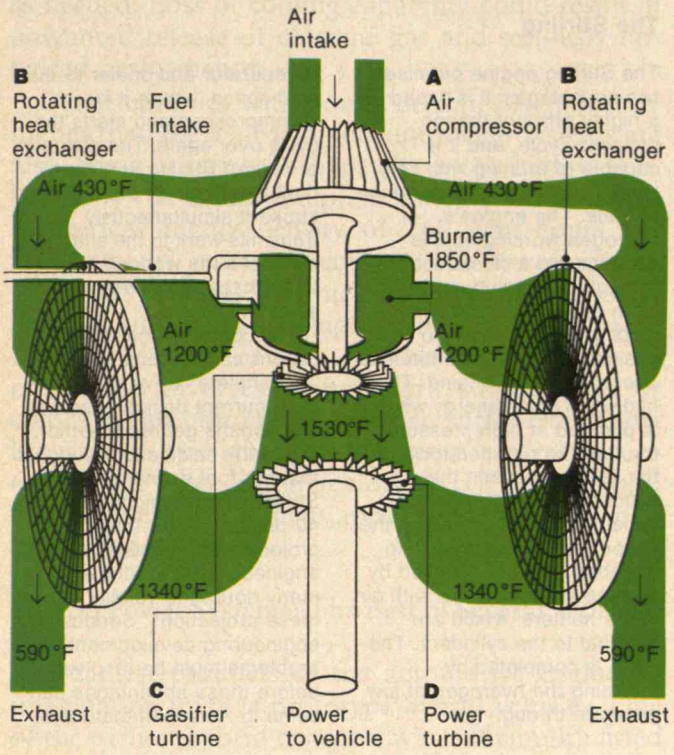
Outside the United States, Volkswagen has made noteworthy progress in the last five years in developing a passenger-car turbine engine; one now being road-tested provides performances equal to that of today's spark-ignition engine, and its emissions are within current federal limits. But fuel efficiency, while improving rapidly in response to design refinements, is not yet equal to that of conventional engines.

Despite these developments, the gas turbine faces an uphill battle for acceptance because of customers' demands for smaller vehicles and reduced expectations regarding performance. The problem is that as the size of the gas turbine is reduced, the engine's inherent losses claim an increasing share of its total power, thereby reducing its efficiency and fuel economy.

The Stirling Cycle Engine: Potential and Problems

Invented by a Scottish clergyman in 1816 and developed during World War II as a power plant for portable generators by the Dutch multinational corporation Philips Gloeilampenfabrieken, the Stirling is theoretically the most efficient of the alternative heat engines now under development. It offers several other advantages over conventional engines as well. The Stirling cycle involves the alternate heating and cooling of an enclosed working fluid (hydrogen). The heat source is a continuous-flow external burner, which allows combustion to be controlled much more precisely than in intermittent combustion systems. The engine is quiet, relatively vibration free, and adaptable to a wide range of liquid fuels, with torque characteristics favorable to vehicular application. The modern Stirling engine is complex and falls far short of the thermodynamic efficiency of which it is theoretically capable — there are several difficult engineering problems to be overcome.

One problem includes sealing at the point where the piston rods leave the closed system containing the working fluid. A second is the design of a low-



The Gas Turbine

The automotive gas-turbine engine — championed early by Chrysler — is driven by the combustion of a mixture of kerosene-type distillate fuel and a high-volume flow of compressed air. A radial compressor (*A*) raises the pressure of the fresh-air stream, which is then heated in heat exchangers (*B*), which are in turn heated by the turbine exhaust gases, before the air stream enters the burner. Following combustion of the fuel in this air stream (which becomes the working fluid after combustion), the hot gases drive both the gasifier turbine (*C*), which drives the compressor, and the power turbine (*D*), which is connected through reduction gears to the vehicle wheels. The gasifier turbine driving the compressor may require up to 85 percent of the engine's available power, and this is the principal source of the turbine's inefficiency. Since a turbine runs most efficiently between 50,000 to 100,000 rpm, the speed of the final driveshaft must be considerably reduced. But there is at least one compensating advantage: the power turbine can function as a torque converter, mating the engine's relatively constant speed with the automobile's widely varying demand. Calculations show that if ceramics become available to improve the performance of gas turbines, their efficiency might be up to 30-percent better than that projected for conventional engines in 1985. If appropriate ceramics do not become available, then all the advantages of the turbine's high power density and smoothness will be lost.

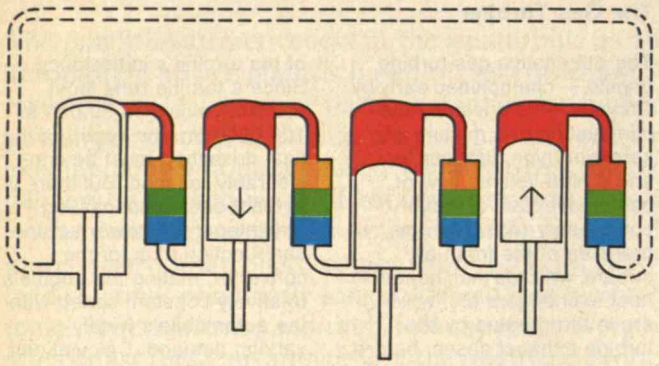
cost heater head that can withstand the 100-atmosphere pressure of the working fluid at temperatures continuously over 750°C. The only satisfactory heater heads made so far have incorporated many small tubes of nickel and chromium "superalloy" that are prohibitively expensive and nearly impossible to mass produce.

A third problem area is power control. The power level in any external combustion system is inherently difficult to control, since altering the fuel flow to the engine has only an indirect effect on the behavior of the working fluid. So far, the most promising means of controlling the power of the Stirling engine, developed by Sweden's United Stirling, is to increase or decrease not the gas temperature but the inert volume in the working fluid system — in effect altering the displacement of the engine. However, the required valves, plumbing, and pumps are complicated, expensive, and trouble prone.

The Stirling engine first attracted the attention of Henry Ford II in 1948; in 1972 Ford joined with the Philips firm to develop a Stirling-powered passenger car. But the fuel economy of a 170-horsepower Stirling in a Ford Torino test vehicle did not match that of the conventional engine. Emissions data indicate that the Stirling will have little difficulty meeting the federal emissions requirements, including that of 0.4 grams per mile of NO_x, and DOE is now supporting the efforts of Mechanical Technology, Inc., United Stirling, and American Motors General to develop the Stirling. The goals are impressive: a 30-percent improvement in fuel economy over that of an equivalent 1984 conventional spark-ignition engine, extremely low emissions, and an ability to use alternative fuels. Meanwhile, significant Stirling programs are also underway in Europe, and automobile and truck demonstrations at United Stirling of Sweden have reportedly been impressive: vehicles showed excellent driveability, extremely low emissions, and fuel economy approaching that of conventional engines.

Electric Power Systems: Charging Up for the 1990s

At the beginning of this century, electric cars outnumbered heat-engine-powered cars on U.S. roads.



Heaters
Regenerators
Coolers
Hot volume
Cold volume

The Stirling

The Stirling engine promises two advantages: it is based on a highly efficient thermodynamic cycle, and it is capable of running with very low emissions on a wide range of fuels. The engine's hydrogen working fluid is contained in a closed loop through four cylinders, with each cylinder's cycle overlapping its neighbor's to ensure smooth and continuous operation of the engine. The hydrogen gains energy when it is pumped at high pressure through the regenerator and the heater between the pistons — the hydrogen expands, exerts a force on the piston, and delivers work to the shaft. Heat is supplied by burning a distillate fuel with air in the heaters, which are external to the cylinders. The cycle is completed by returning the hydrogen at low pressure through the regenerator and cooler to the cool space, where it is recompressed and starts the cycle over again. The piston in a modern Stirling engine is double-acting: on the downstroke it simultaneously transmits work to the shaft and displaces the working fluid through the heater and into the adjoining cylinder.

The coupled motion of the pistons can be achieved with a "swashplate" drive, though most current designs use two crankshafts geared together. Computer calculations suggest that the fuel economy of a Stirling engine might be up to 40-percent better than projected for conventional engines in 1985, although many doubt the validity of these projections. Serious engineering development problems must be resolved before these advantages can come to American motorists.

But within 20 years, electric vehicles had all but disappeared, having failed to keep pace with their gasoline-powered rivals in power, speed, range, convenience, and cost. Almost all the shortcomings of the electric car could be traced to inherent characteristics of the lead-acid battery: heavy weight and inadequate energy-storage capacity.

Recent developments suggest that the electric car may soon contend successfully for a share of the American auto market. What has changed the picture is the spectre of increasingly frequent gasoline and diesel fuel shortages. No longer must electric vehicles be fully competitive with conventional-engine vehicles to capture a profitable share of the market — the higher cost and range limitations of an electric vehicle will seem a modest inconvenience to motorists whose neighbors' cars are immobilized for lack of gasoline.

New technology, too, is moving the electric car to renewed popularity. Microprocessors have made possible substantial economies in power control systems (the rheostat controller can now be replaced with a more efficient "chopper" type) and facilitated the use of regenerative braking. But most important of all, significant progress has recently been reported in battery research: General Electric and Chrysler have introduced a zinc/nickel battery with an energy density of 70 watt-hours per kilogram, nearly twice that of the conventional lead-acid battery (36 watt-hours per kilogram), over a wider range of ambient temperatures. General Motors has established a project center (such a center resulted in GM's front-wheel-drive X-cars) to develop a zinc/nickel-powered electric car to be marketed in the mid-1980s.

Gulf and Western Industries has developed a zinc/chloride automotive power system with a theoretical energy density of 830 watt-hours per kilogram, enough to give a range of 150 miles at 55 mph in a Volkswagen Rabbit, and the company has announced its intention to open a facility to build electric cars by 1983 or 1984. But Gulf and Western's zinc/chloride system is considerably more complex than the zinc/nickel battery: the chlorine must be stored in a hydrate, and this requires a cooling unit as well as a circulation pump and heat ex-

changer to release the chlorine gas from the hydrate as needed. Loss of cooling capability could result in unwanted release of chlorine gas and seriously impaired performance.

Other batteries with power densities significantly higher than the lead/acid and zinc/nickel systems are also being studied. Perhaps the most highly publicized is the sodium/sulphur battery, which has a theoretical energy density of 760 watt-hours per kilogram. Its materials cost are the lowest of the advanced batteries; its chief drawback is its shorter life resulting from the high operating temperature required (300° to 350°C). Another promising group of systems involves lithium with sulphur, air, or chlorine. But lithium systems also suffer from short life caused by high operating temperatures (up to 650°C for the lithium/chlorine cell). Successful high-temperature systems appear to be at least ten to fifteen years away.

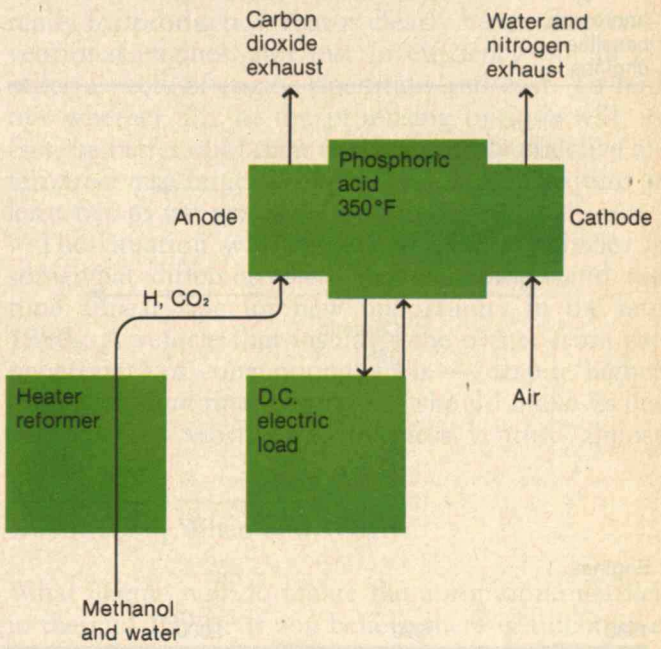
Hybrid Power Systems: The Best of Several Worlds?

The zaniest products of the automotive engineer's imagination involve prototype hybrid vehicles. One of the earliest hybrid concepts was a Plymouth fitted with a pneumatic transmission in the 1930s. The car's engine provided power for steady cruising and an air compressor; the rear wheels were driven either conventionally or from compressed air by means of a converted steam engine when extra power was required for accelerating and climbing hills. The "air engine" could be reversed during deceleration to pump additional air into a storage tank, and exhaust gases were used to heat the tank, further increasing the pressure of the air it contained.

The same general idea — a prime mover and an on-board rechargeable energy storage system — took a different format in the 1960s at the Technical University at Aachen, Germany, where a Volkswagen bus was fitted with a small gasoline engine for cruising and a flywheel for energy storage. The builders claimed 60-percent fuel savings and improved acceleration.

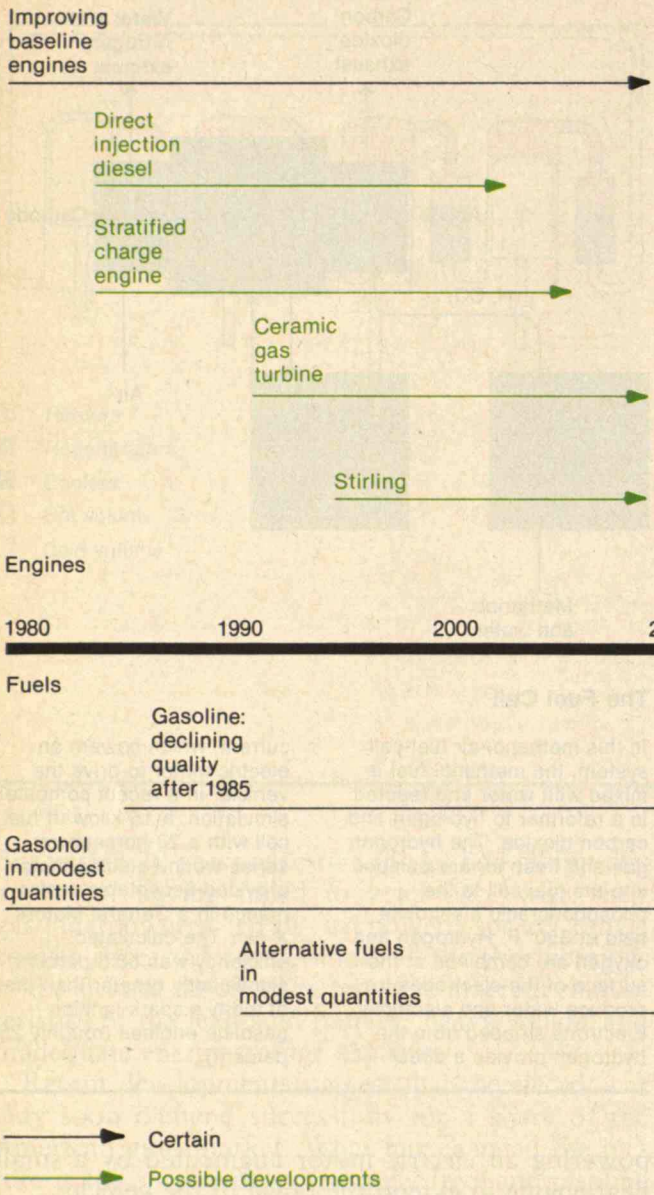
Prior to the urgency of the petroleum supply problems in the 1970s, the typical hybrid configuration had a small, constant-speed heat engine that charged storage batteries, which in turn powered an electric motor. Now the typical concept includes batteries (charged externally and by regenerative braking) powering an electric motor augmented by a small heat engine to extend the range of the vehicle.

The most promising type of hybrid — at least in principle — is the fuel-cell/battery vehicle (*see "The Case for Fuel-Cell-Powered Vehicles" by J. Byron McCormick and James R. Huff, August/September, p. 54*). Like a battery, a fuel cell converts stored chemical energy into usable electrical energy. The difference is that the fuel cell needs a continuous source of fuel (conventionally, hydrogen) while the battery consumes its electrode material, which later must be restored by recharging. The fuel cell operates as the reverse of the classic electrolysis reaction:



The Fuel Cell

In this methanol-air fuel-cell system, the methanol fuel is mixed with water and reacted in a reformer to hydrogen and carbon dioxide. The hydrogen gas and fresh air are pumped into the fuel cell to the phosphoric-acid electrolyte held at 350° F. Hydrogen and oxygen are combined at the surface of the electrodes to produce water and electricity. Electrons stripped from the hydrogen provide a direct current, which powers an electric motor to drive the vehicle. In a recent computer simulation, a 15-kilowatt fuel cell with a 20-horsepower series-wound electric motor provided acceptable performance in a General Motors X-car. The calculated efficiency was 38.5 percent, significantly greater than that of today's spark-ignition gasoline engines (roughly 25 percent).



Future Fuels and Engines

Our fuels future can be thought of in four phases, each with its particular impact on automotive engines. Before 1990, motor vehicle fuels will come predominantly from natural petroleum and will be used in conventional spark-ignition and diesel engines. Modest and increasing amounts of alternative fuels from shale oil and coal will be included beginning in 1990; by 2010 fuels will come from natural petroleum and alternative sources in roughly equal proportions; and by 2030 alternative fuels are likely to dominate. Significant problems in maintaining gasoline and diesel fuel quality are likely in the mid-1980s because of additional processing requirements. Meanwhile, conventional spark-ignition and diesel engines will not be challenged until late in the current decade, when new engines such as the stratified-charge spark ignition and the direct-injection diesel can be mass-produced. More exotic technologies cannot be foreseen before the 1990s. In general, engine developments are likely to occur sooner than fuel developments; little thought has been given to engine options for the fuels forecast for 2010 and after.

instead of applying electrical power directly to dissociate water into oxygen and hydrogen, the fuel cell reacts those elements catalytically to yield water and electricity.

The fuel cell possesses two inherent advantages over even the most efficient heat engine: its thermal efficiency in converting stored energy to usable work is far higher, theoretically up to 83 percent, though researchers are achieving only about 50 percent today; and it does not pollute. The basic vehicular configuration now under development couples a fuel cell and a battery in a hybrid format. The fuel cell's power is used for level cruising and battery recharging, and the batteries are used for acceleration, climbing hills, and the ten-minute start-up period now required to reach operating temperature.

The oxygen required by the fuel cell can be taken directly from the air, and — in theory — any hydrocarbon fuel can be used with an on-board reformer to produce the required hydrogen. Methanol

With so many apparently promising options available, why does it seem to be "technology as usual" within the auto industry?

is now the most promising long-term fuel because of its availability from renewable sources, and because its emissions are water vapor and carbon dioxide. Computer simulations of a fuel-cell-powered Volkswagen Rabbit using methanol show superior efficiency and performance equivalent to the diesel Rabbit in both stop-and-go and highway driving.

Though it has much potential, the fuel cell is currently an outsider. Its characteristics as an automotive power system are not yet well defined, and substantial materials problems must be overcome before it is a practical proposition.

Why Not Soon?

With so many apparently promising alternative engine options, why does it seem to be "technology as usual" within the auto industry? In reality, the industry is now involved in an unprecedented, massive effort to make its products more attractive in the marketplace. What began in the mid-1970s as a downsizing effort to comply with government fuel-economy standards set for the early 1980s has become a fight for survival. Vehicle size, fuel economy, and cost are the key issues. The problem is to take the initiative in these areas away from foreign carmakers whose markets have traditionally been dominated by the considerations that now motivate American buyers.

In the short term, the most reliable and cost-effective means of achieving higher fuel economy involve reduction of vehicle weight. The largest gains come through downsizing. Large weight reductions are also achieved by converting to front-wheel drive, which increases interior space for a given wheelbase while eliminating the weight of the conventional driveshaft, differential, and rear-axle components. Materials substitution and detailed redesign yield additional weight reductions.

Significant gains in efficiency are also being sought through improvements in new, smaller conventional spark-ignition and diesel engines and through teaming these with more efficient transmissions (with more gears and torque-converter lockup in cruising gear to reduce losses). Optimization of the engine-transmission-vehicle system is a particularly effective route to improved efficiency because it enhances rather than compromises the performance and comfort of the product.

Alternative engines do not appear in this list for one very simple reason: no alternative engine is ready for production that is clearly better than conventional engines, not just in efficiency but in all other aspects of engine operation and cost. To find out whether any of the promising options will, in fact, be better, and then to bring a truly effective alternative into large-scale production, will require at least five to ten years.

The situation with respect to electric vehicles is somewhat different. Here the technology and the time appear ripe for new opportunity in the late 1980s. A vehicle that insulates the owner from the uncertainty of conventional fuels — despite higher initial cost and limited range — should make its development a worthwhile business venture almost immediately.

If Not Soon, When and What?

What engine will dominate the automobile market in the mid-1990s? If you believe there is a definitive answer to that question, you fail to understand the problem. Automakers are in the midst of an increasingly sophisticated analysis of the future potential of coventional engines and all these alternatives. It is a far-from-trivial exercise; indeed, an appropriate methodology has yet to be fully developed.

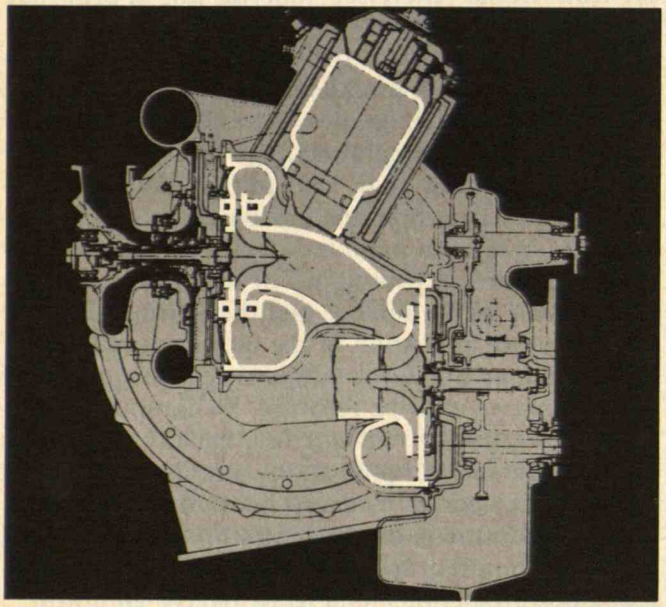
We usually evaluate the potential of a new development in a well-established technology — in the conventional spark-ignition or diesel engine, for example — by extrapolating from data generated by prototype engines that incorporate that new development. This approach has tended to underestimate the long-term potential of current engine technologies. Current prototypes of more radical alternatives such as the turbine and the Stirling also give an inaccurate indication of the ultimate potential of such concepts but for a different reason: too many problems remain to be resolved. So computer simulations of radically new engines, usually with gross but unavoidable simplifications, are used to predict future performance. Because many of the inherent loss mechanisms in such engines are unknown and therefore omitted from the simulations, the performance predictions tend to be overly optimistic.

Comparative engine evaluations are an ongoing activity. The rate of development of each new concept will depend on new technological opportunities, fuel cost and availability, marketable vehicle size, and emissions standards. However, we can

Ceramics: The Card That May Change the Game

Ceramics may be the trump card that determines which engine powers the automobiles of the 1990s. Ceramic components could improve the performance of internal-combustion engines, and they will be essential if other heat engines are to be competitive in efficiency at acceptable cost. Ceramics offer low thermal expansion; high resistance to corrosion, abrasion, and wear; and cost lower by about an order of magnitude than the superalloys now required to achieve some of the same qualities. The chief disadvantage of ceramics is their brittleness under mechanical stress and thermal shock. They also require unusual care in manufacture, since their mechanical properties depend on the purity, fineness, and uniformity of the particles of raw material and on careful control over the casting process itself.

If these requirements can be met at reasonable cost, structural ceramics are likely to find application in rotors and regenerators for gas-turbine engines; heater heads, regenerators, and pistons for Stirling engines; and ceramic piston crowns, cylinder heads, and linings for prechambers and exhaust ports in diesel engines. Without high-temperature ceramic components, the gas turbine and perhaps the Stirling engine may never be economical in automotive applications. — *J.H. and J.W.* □



For adequate efficiency, an automotive gas-turbine engine must utilize ceramics for turbine vanes and rotors and for combustor and turbine linings and scrolls (*above*) — a difficult technical challenge.

make some predictions based on current estimates of the potential of each option, and suggest how certain future circumstances are likely to influence each engine's prospects. It is unlikely that the future will be as monolithic as the past, dominated for 50 years by a single engine type. Rather, several systems are likely to serve several large submarkets based on different requirements for carrying capacity, range, and performance.

Over the next decade and more, the spark-ignition engine, which has emerged surprisingly unscathed from its "crisis" with environmental controls, and the diesel, which still faces some emissions hurdles, will be steadily and substantially improved. The current prechamber diesel may well be replaced by a direct-injection diesel — the most efficient internal-combustion option available. But only the commitment of substantial engineering resources and considerable success with emissions problems will make this possible; the automobile industry appears to be evaluating carefully whether to begin this process.

Two factors might discourage the industry's emphasis on refining the existing spark-ignition and prechamber diesel engines, as well as its new interest in the direct-injection diesel. The first would be a shortage of gasoline and diesel fuel of sufficient quality to meet the needs of these conventional engines, which have highly specific fuel requirements. This problem is likely to become important in five to ten years and could shift the industry's development emphasis to engines with less demanding fuel requirements — the direct-injection stratified charge, the gas turbine, and the Stirling. Of these, by far the easiest to bring into production will be the direct-injection stratified-charge engine; given substantial development resources, this could be ready for mass production within the second half of the 1980s. Although the concept is not being given this kind of support, increased research and development efforts appear worthwhile.

The second factor would be the successful development of ceramic rotating components. Such a breakthrough would spur development of a turbocharged direct-injection diesel and a gas turbine; indeed, this development is essential if the gas turbine is to be competitive with respect to efficiency. But since the trend toward smaller vehicles works against the gas turbine, we rank it as an outsider in the race.

Of all the heat engines, the Stirling is the most

At least five years will be needed to identify the more promising options, and bringing the winners into mass production will take another five to ten years.

difficult to rank. It handily wins most fuel-efficiency comparisons based on computer simulation studies, but it is likely to remain largely an unknown quantity for the next several years. Good experimental data on the Stirling will be required to earn it more extensive research and development support.

It now seems likely that electric-powered automobiles will stage an end-run in the late 1980s for the small-urban-vehicle market. Shortages of liquid fuels — whenever they occur — will create substantial demand for such vehicles, even if they have limited range, low performance, and high cost. Some form of transportation will clearly be better than none.

Beyond the 1990s, the crystal ball becomes very cloudy. Very little thought has yet been given the longer-term future beyond the year 2000, when petroleum-based fuels will be scarce and much more expensive and other energy sources must assume a major role in powering our transportation systems. Perhaps a fundamentally more efficient concept such as the fuel cell may then be an appropriate choice.

No one yet knows. It will be important to keep sifting the evidence and to invest in research and development in whatever alternatives seem most promising. It will also be important to keep an open mind.

John B. Heywood, professor of mechanical engineering at M.I.T., is director of the Institute's Sloan Automotive Laboratory. He came to M.I.T. for graduate study (S.M. 1962, Ph.D. 1965) from Cambridge University, returned to England to work with the Central Electricity Generating Board, and then opted for life in the U.S. as a member of the M.I.T. faculty in 1968. **John Wilkes**, assistant professor of science writing and technical writing at M.I.T., came to Cambridge in 1979 from a similar post at the University of California at Santa Cruz. He has campaigned a Morgan Plus Four and written for *Road and Track*.

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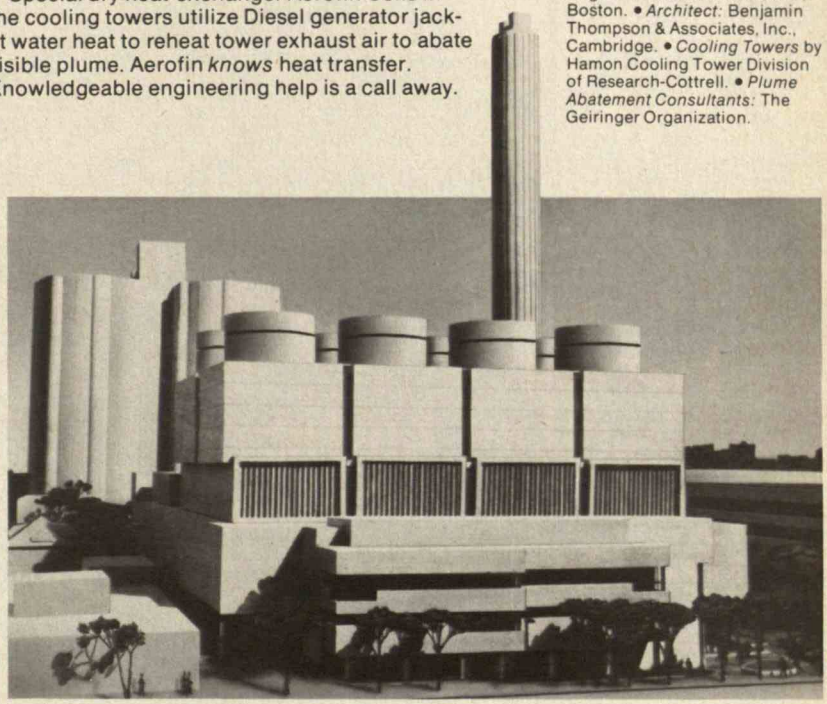
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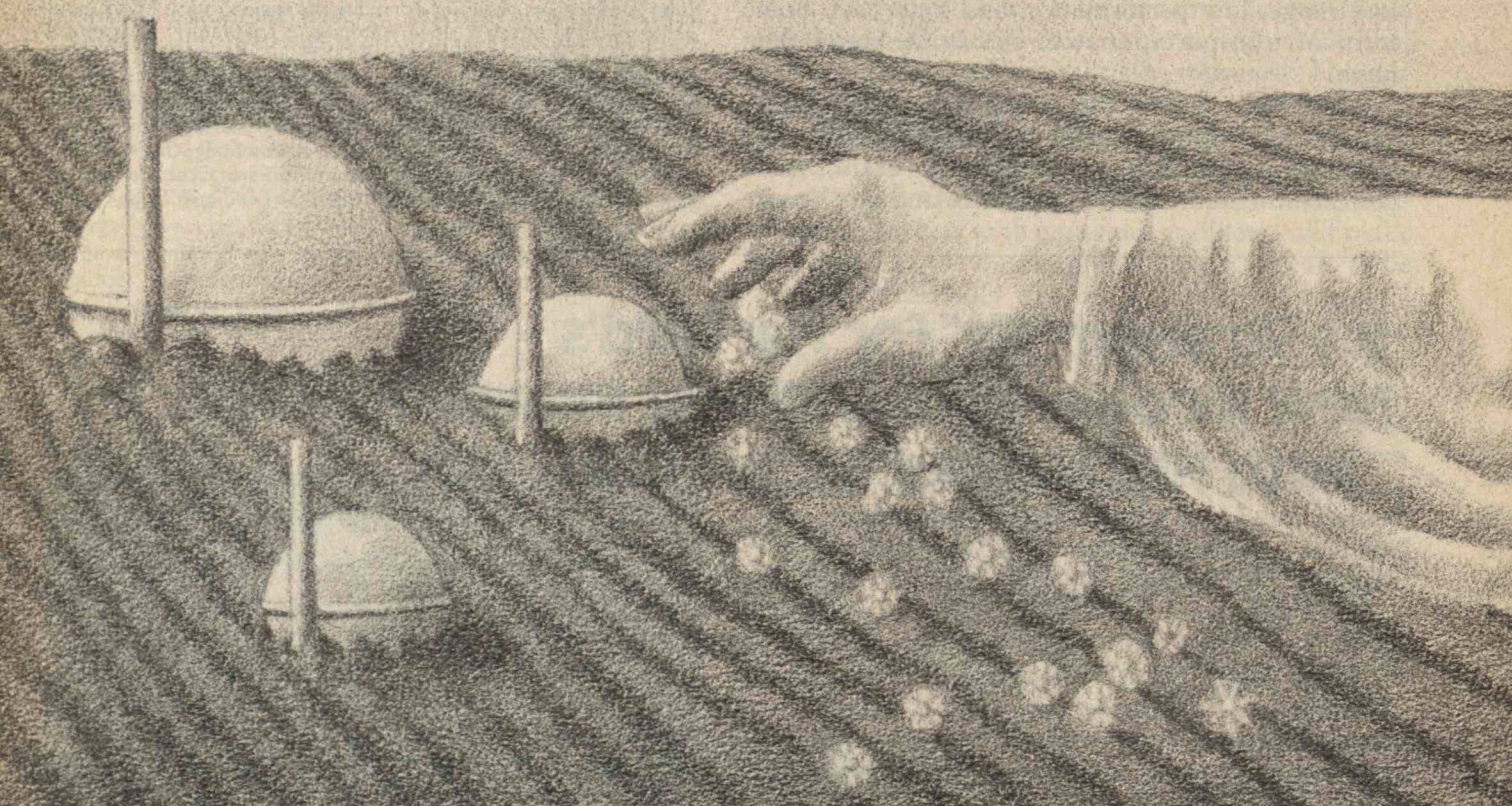


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What would the American energy picture be like if the executive branch controlled the entire country's generation and distribution of electricity, built nuclear reactors, could bypass Congress, and essentially ignored public opposition? Look at France.

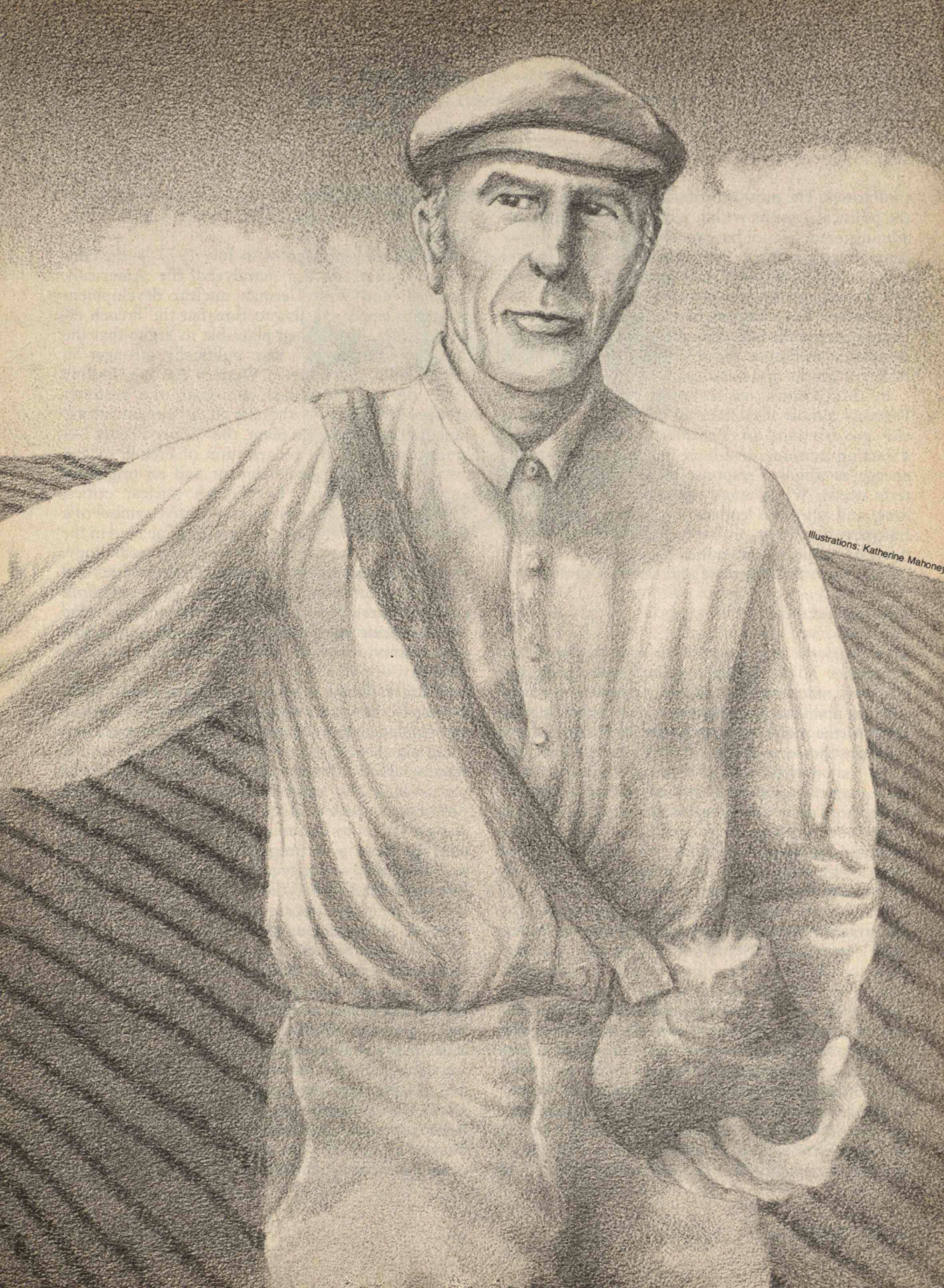


The French Nuclear Harvest: Abundant Energy or Bitter Fruit?

by Irvin C. Bupp

Throughout the Western countries, and particularly in the United States, nuclear power has been increasingly cast in the role of a transition technology — as an interim, stopgap measure necessary, if not ideally desirable, as a bridge to renewable energy sources. But France, nearly alone, appears to be transforming the expectations for nuclear power of the early 1970s into reality for the early 1980s: it is developing the technology as a permanent, long-range substitute for oil to generate electricity.

The French nuclear program has now diverged so broadly from the programs of other Western countries that it is much easier to draw contrasts than



Illustrations: Katherine Mahoney

similarities. The most profound contrasts are among the political systems within which the programs are administered. France has traditionally been a highly centralized country controlled by a powerful technocratic elite. This centralization and control are a basic characteristic of French nuclear development. To a degree barely imaginable in the United States, the officials who manage nuclear development in France are able to act with few or no effective checks and balances.

In this political environment, and in light of France's almost total lack of fossil-fuel resources, the government of President Valéry Giscard d'Estaing continues to adhere to the vision of atomic energy as a major response to the country's long-term needs. While many individual political, business, and scientific leaders in neighboring Western European countries probably still share this vision, domestic political difficulties have obliged them to modify both their rhetoric and their programs.

How to Succeed

Two years — 1969 and 1974 — mark significant milestones in the French nuclear power program. The first milestone was when the government decided to abandon gas-graphite reactor technology in favor of the more economical American light-water systems; the second was when French leaders decided that nuclear power would become the country's major source of electricity within a decade. Since then, there have been some minor delays and some not-so-minor cost overruns, but the government's program to produce 65 to 70 percent of French electricity from nuclear power by 1985 is proceeding about as planned.

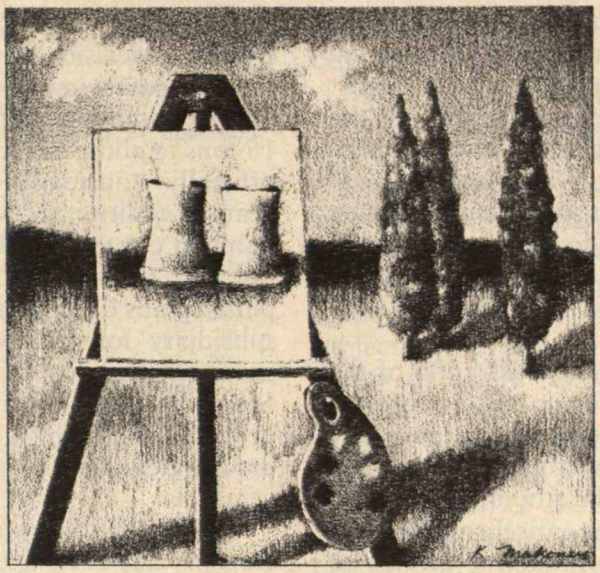
The table on page 35 lists the reactors ordered by the government-owned utility, Electricité de France (EDF), between 1973 and 1980, representing a total capacity of almost 33 billion watts, or gigawatts (gw). The first column in the table does not cite a mere intention, or even the start, of an administrative proceeding — it represents the effective commencement of plant construction. Since EDF is able to build a nuclear power plant in about six years, most of the reactors listed will probably be operating by the mid-1980s. In addition, the government has recently decided to accelerate the country's reactor construction program even further: 10.5 gw of additional capacity will be ordered by the end of 1981. Ironically, this decision was made public in April 1979, two weeks after the accident at Three Mile Island.

Only three years ago — in July 1977 — the controversy that all but paralyzed the American, Swedish, and West German nuclear development programs appeared also to threaten the French effort. In fact, it was then plausible to argue that the "ecology movement" was politically stronger in France than elsewhere in Western Europe. In July 1977, the riot, bloodshed, and death of a protester at Creys-Malville — the site of a "preindustrial" breeder demonstration plant, the "Super-Phénix" — seemed to augur the polarization of French society into a pronuclear establishment and an organized antinuclear minority. For French nuclear critics, Creys-Malville had become an evocative symbol of a national decision-making apparatus gone mad in the pursuit of an unsafe and unnecessary technology. For the government and the pronuclear business and scientific communities, however, Super-Phénix stood for French technological preeminence. Deep national pride made it imperative to ride roughshod, if necessary, over the irrational objections of a minority.

In *Light Water*, a book I coauthored with Jean-Claude Derian that was published shortly thereafter, we concluded that "the 1974 to 1977 [French nuclear] debate was settled by power — but by power separate from authority. Electricité de France, for its part, was acutely aware of the precariousness of its position. A senior official privately assessed the chances of successful completion of the present nuclear program — a program he helped to develop and continued strongly to support — at less than one-third. He believed there was an equal probability that political opposition would be successful in seriously compromising the whole program. He was troubled that the outcome would probably be determined by passion, not reason. In his view, French political institutions had not satisfactorily handled the nuclear power issue. The program was proceeding as planned, although with some delays, but with a heavy political mortgage."

That was 1978. Yet today the program is proceeding roughly according to plans laid from 1974 to 1975. The Tricastin isotope-separation plant has begun operation, several new reactors have been hooked up to EDF's transmission grid, construction is well underway at Creys-Malville, and La Hague

The average French citizen has returned to traditional indifference about technical choices made by the state.



(on the Normandy coast) is currently the only facility in the world where spent fuel from commercial light-water reactors (LWRs) is being reprocessed, albeit at a rate substantially lower than anticipated.

What happened to "the heavy political mortgage"? There is no simple answer, but political leadership seems to be the key. First, the coalition supporting Giscard d'Estaing won the 1978 National Assembly election. In doing so, it put a left-wing coalition — and particularly the Socialist Party — into the greatest disarray in years. By 1979, Giscard was the leader of one of the most politically secure governments among the Western democracies, and he was also personally committed to the success of the French nuclear development program. But it is at least as important that the program's chief architect and guiding spirit — André Giraud, former head of the French Atomic Energy Commission (CEA) — now has ultimate line responsibility for the program's execution as head of the Ministry of Industry. The CEA and EDF both report to Giraud, and he is reputed to enjoy deep respect from the president for his technical competence. (One has to go back to President Eisenhower's first term, when Lewis Strauss held simultaneous positions as head of the Atomic Energy Commission and advisor to the president, to find a parallel in the United States.)

There is more behind the momentum of the French nuclear program, however, than personalities and personal relationships — there is also an institutional structure. Enormous operational power has been concentrated in two complementary agencies: the CEA, for the development of fuel-cycle facilities and for progress on breeder reactors; and the EDF, for LWR construction and operation. But these agencies, and the arrangements between them, are effects, not causes. The key point is that in France, the nuclear development program is a high-priority objective of a strong, centralized government. The administrators responsible for its success can draw on concentrated fiscal and technical resources and are free to take decisive action.

Then there are "the prefects": the decentralized arms of a highly centralized system. In the regions outside Paris, they represent the administration with extensive power and authority for maintaining law and order. Supporting the French govenment's desire for relatively undisturbed progress in its nuclear program, the prefects have often used their power at critical sites by deploying local law-enforcement authorities to block the activities of antinuclear demonstrators.

To round out governmental solidarity, the French judicial machinery has generally been hostile or indifferent to antinuclear objections, in marked contrast to the judiciaries of the United States and West Germany. When trade-offs between public and private interests are involved, the French courts have exhibited a long-standing bias toward officially sponsored projects. French courts nearly always come down on the side of what they consider to be the "public interest" — namely, the position of the

The officials who manage nuclear development in France are able to act with few or no effective checks and balances.

administration. French antinuclear forces, on the other hand, have been cast in the role of promoting *private* interests, and consequently have been almost uniformly unable to find de facto allies on the bench. An especially significant example was in May 1979, when the Conseil d'Etat — the rough equivalent of the U.S. Supreme Court in matters of citizen grievances on actions of the government — summarily rejected all 89 petitions by various ecological and antinuclear groups against the continued construction of Super-Phénix.

All this, of course, explains the frustration of the antinuclear movement in France: in spite of greater activity than in most other Western countries, they have failed to modify the government's plans significantly. But the strength of the administration and the hostility of the courts do not entirely explain this outcome; the failure of the antinuclear groups to mobilize French public opinion to their cause should also be underlined. Except in a few regions such as Brittany, where local opposition contributed to the postponement of EDF projects, an antinuclear movement with political staying power has never materialized. Instead, there have been only periodic demonstrations at proposed nuclear sites.

This may mean that the government's logic — that the need for nuclear power, as compensation for France's lack of fossil-fuel resources, is absolute — has been more convincing than critics' arguments that the cure is worse than the disease. It may also mean that after a temporary period of emotion during 1974 and 1975, the average French citizen has returned to traditional indifference about technical choices made by the state (as long as they do not affect his or her own backyard).

The Reprocessing Plant at La Hague: An Achilles Heel?

With the closing of the English plant at Windscale after an accident in 1973, the French unit at La Hague became, and is today, the world's only operational facility for reprocessing light-water reactor fuel. Using a modification of American Purex technology (in which spent fuel is sequentially immersed in acid baths, with the reprocessed fuel later precipitated out), La Hague began to reprocess low-irradiated fuel from gas-graphite reactors in the late 1950s (the "UP1" plant). This plant was augmented in the 1960s ("UP2"). In 1976, the CEA added a "front end" to UP2, complementing the government's decision to switch to light-water reactors.

In the past two years, the amount of fuel reprocessed per batch has been progressively increased from 18 tons to about 120 tons. However, the plant is still officially considered experimental, with several years of additional development required to reach its nominal capacity of 400 tons per year of highly irradiated uranium oxide fuel from LWRs. But the public plans of Cogema — the CEA's wholly owned subsidiary for fuel-cycle activities — nevertheless project a capacity of 800 tons per year by 1985. Meanwhile, the original UP1 plant continues to reprocess gas-graphite metallic uranium fuel — approximately 400 tons per year over the past two years.

With the full backing of the French government, Cogema has been extremely active in the commercial arena. Between 1975 and 1979, it negotiated a series of long-term contracts with several foreign governments to reprocess LWR fuel. These contracts incorporate a cost-plus-fee formula with the twin objectives of raising the capital needed to expand La Hague facilities and adding as much as 10 billion francs ($2.5 billion) to the French balance of payments. Cogema plans to reprocess a total of 6,000 tons of foreign LWR fuel in the coming ten years, and contracts have already been signed with Japan (1,600 tons), West Germany (705 tons), Sweden (626 tons), Switzerland (469 tons), Belgium (324 tons), and the Netherlands (120 tons).

Despite this apparent progress, some believe the well-laid plans for La Hague are in real trouble, possibly boding ill for the entire French nuclear program. Cogema officials, at least publicly, remain sanguine, claiming that La Hague will soon reach nominal capacity and that current technical difficulties are no more than what is to be expected when expanding any new and complex process from pilot plant to industrial scale. But the position of the second largest labor union in the country — the CFDT (Confédération Française Démocratique du Travail) — is that the technical problems of La Hague are quite serious, perhaps intractable.

Many of CFDT's members are scientists and technicians from CEA and EDF — well placed and technically qualified to discuss the details of nuclear development in France. CFDT contains some of the few informed critics of the government's nuclear program and has been unique in being able to

The program to produce 65 to 70 percent of French electricity from nuclear power by 1985 is proceeding about as planned.

Reactors ordered between 1973 and 1980

Year of the program	Site and reactor	Size (megawatts)	Start operation
1973	Bugey 4	905	6 - 79
1974	Bugey 5	905	10 - 79
	Tricastin 1	925	12 - 79
	Tricastin 2	925	3 - 80
	Gravelines 31	925	11 - 79
	Gravelines 32	925	4 - 80
	Dampierre 1	905	3 - 80
1975	Tricastin 3	925	10 - 80
	Tricastin 4	925	81
	Gravelines 33	925	10 - 80
	Dampierre 2	905	7 - 80
	Dampierre 3	905	81
	Blayais 1	925	81
1976	Gravelines 34	925	81
	Dampierre 4	905	81
	Blayais 2	925	81
	St. Laurent 31	905	81
	St. Laurent 32	905	81
	Paluel 1	1285	83
1977	Blayais 3	925	82
	Blayais 4	925	83
	Chinon 31	905	82
	Chinon 32	905	82
	Creys Malville	1200*	83
	Paluel 2	1285	83
1978	Cruas 1	905	83
	Cruas 2	905	83
	Paluel 3	1285	84
1979	Cruas 3	905	84
	Cruas 4	905	84
	St. Albion 1	1270	84
	Flammanville 1	1285	85
	Cattenom 1	1270	85
Total		**32650**	

*Liquid Metal Fast Breeder Reactor

Since the early 1970s, a series of decisions have been made that add up to a comprehensive set of research, development, and construction programs. The significance of nuclear power as a long-range, as opposed to *interim*, solution forms the basis of the government's strategy.

document technically the grounds for many of its criticisms.

Although the union has never questioned France's need to develop nuclear power, for several years it has been a relentless critic of the specifics of the government's program — in particular, those aspects involving reprocessing and breeder reactor development. It argues that the government's crash attempt to simultaneously build LWRs, begin reprocessing, and commercialize breeder technology is subjecting the general public and atomic workers (many of whom are CFDT members) to needless risks.

CFDT also objects to the program's organization. In the early 1970s, it unsuccessfully fought Giraud's reorganization of the CEA, claiming that a public agency was being replaced with profit-motivated, private-sector institutions. The focus of this battle was the creation of Cogema, to which all the CEA's fuel-cycle programs were transferred. Cogema represented not only the largest transfer of CEA programs to a profit-seeking organization — involving some 8,000 workers — but was also fully responsible for the future management and operation of isotope separation and reprocessing. CFDT argued that Cogema's profit seeking would be incompatible with the protection of workers and the public from the hazards of nuclear materials.

CFDT's distaste for Cogema has not diminished over the years. In 1976 it published a technical report accusing Cogema of mismanagement at La Hague that exposed the plant's workers to unacceptable levels of radiation. The report further claimed that Cogema's commercial priorities had allowed safety conditions to deteriorate. CFDT still considers the problem unresolved and wants La Hague shut down until working conditions are improved and the government reconsiders the decision to hand over management of fuel-cycle services to "private interests." Moreover, CFDT strongly objects to Cogema's negotiation of contracts to reprocess large amounts of foreign fuel while, in the union's opinion, acceptable conditions have yet to be established for safely reprocessing fuel from domestic reactors.

CFDT officials are skeptical that the terms of Cogema's foreign reprocessing contracts can be met. As evidence of Cogema's serious technical difficulties with the Purex process, their technical publications stress the relatively small amounts of oxide

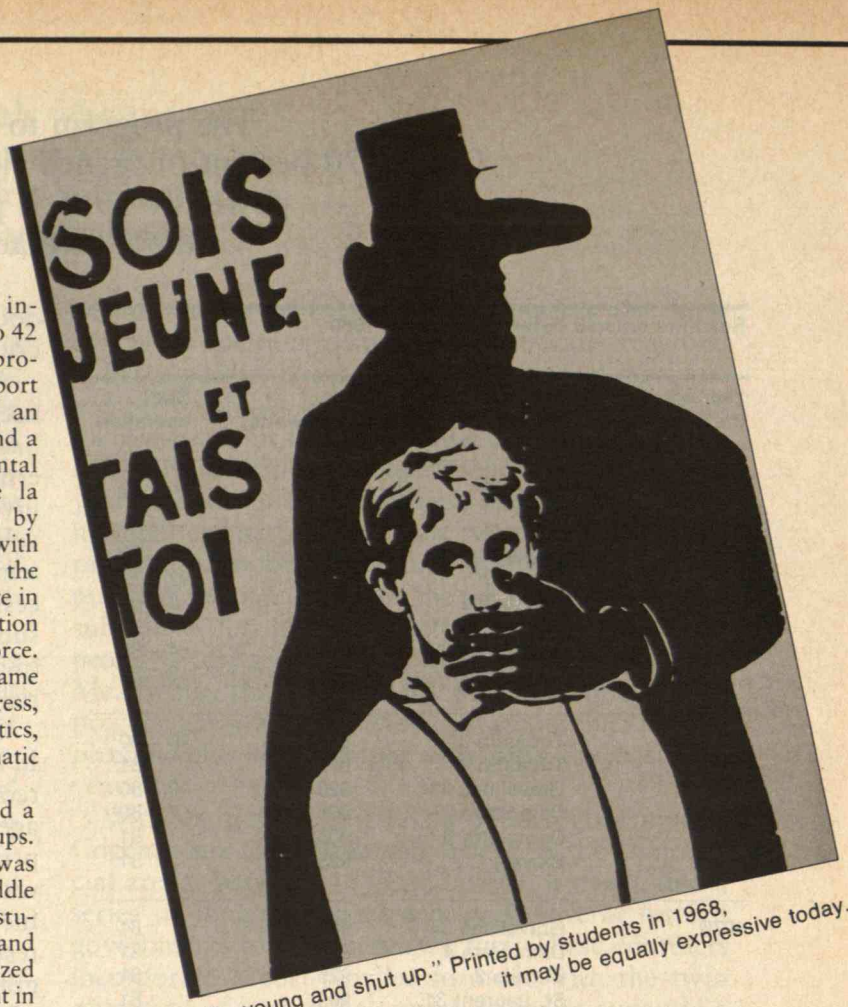
The Antinuclear Movement in France

by Dorothy Nelkin and Michael Pollak

When the French government suddenly announced plans for rapid expansion of its nuclear program in 1974, the country's antinuclear movement, previously concerned almost exclusively with local siting disputes, turned its attention to national nuclear policy. Hundreds of well-known scientists warned of the dangers of nuclear power in a widely circulated petition (L'Appel de 400) that lent legitimacy and credibility to what had been just a series of scattered protests. This national perspective was further enhanced when an "ecology" candidate — René Dumont — ran a strong antinuclear presidential campaign, forcing the traditional environmental associations to take positions on nuclear power.

So French public opinion concerning nuclear power began to polarize. Surveys indicated that those in favor of the technology declined rapidly from 74 percent in 1974 to 47 percent in 1978, while those opposed increased from 17 percent to 42 percent. This change provided considerable support for the development of an antinuclear movement, and a Paris-based environmental group — Les Amis de la Terre, formed in 1970 by people who had worked with the American Friends of the Earth — took the initiative in organizing public opposition into a national political force. Nuclear power soon became a focus for the ecology press, an issue in electoral politics, and the subject of dramatic mass demonstrations.

The movement attracted a number of different groups. The main constituency was young, educated, and middle class, including many students but also scientists and other professionals socialized during the period of dissent in the 1960s, who retained critical perspectives on the social implications of technological change and the government's authority. In addition, farmers concerned about the industrialization of rural areas, or directly affected by proposed construction, joined the local and regional organizations to oppose specific siting decisions. In places such as Brittany, the movement attracted the "regional autonomists" who perceived nuclear power as a vehicle for further political centralization. The national movement was also joined by feminist and other emancipatory groups attracted by the revolt against the political establishment.



"Be young and shut up." Printed by students in 1968, it may be equally expressive today.

Thus, the antinuclear discourse embraces a wide range of social and political concerns. The pamphlets disseminated by the movement address agricultural problems for farmers, occupational hazards for workers, the dominance of large firms for small business owners, capitalism as the driving force behind nuclear expansion for leftists, and the destruction of traditional social structures for conservatives. This diverse agenda is underlaid, however, by some powerful common themes: an apocalyptic image of the destructive potential of nuclear power; a pessimistic vision of an ecological, economic, and cultural crisis; and a critical

fuel that have been reprocessed. CFDT argues that this technology, originally developed to reprocess lightly irradiated military fuel, had already been pushed to its limits to handle fuel from EDF's gas-graphite power reactors. For LWR fuels with burnups (i.e., time spent in the reactor core) five to ten times higher, Purex technology is considered very questionable, and its efficiency decreases with the scale of the reprocessing facility. Thus CFDT concludes that, because Cogema's commercial aggressiveness is risky at best and highly unrealistic in its timing, the foreign contracts should canceled.

Cogema maintains that CFDT's claims are not well founded. With total CEA control, the company remains in the public sector because it is operated completely according to governmental priorities. Moreover, the company points to the positive results of recent negotiations with trade unions: even CFDT has now accepted Cogema's proposals on the status of workers transferred from CEA.

Cogema concedes certain technical difficulties at La Hague, but the company maintains they are merely mechanical — fitful plumbing, for example — and have nothing to do with the basic reliability

analysis of its sociopolitical roots. Opposition to nuclear power in France has become a struggle for "human survival" and "political justice" against the powers of "nuclear technocracy" and "electro-fascism."

The apocalyptic character of the antinuclear discourse in France reflects a pessimism that often invades the cultural mood in times of recession or after periods of rapid social change. Its moral tone recalls the great debates of the late nineteenth century on the impact of industrialization, suggesting a place for the antinuclear movement in both the conservative and radical traditions. For conservative participants in the movement, nuclear power is a moral issue; concepts of "sin," "values," "discipline," and "austerity" are sprinkled throughout their discourse. For young political ecologists on the left, political and social images of "ecotopia," "emancipation," and the "quality of life" have prevailed. Though it helped make possible broad public support, this diversity led to difficulties in communicating with the traditional political parties. To maintain a broad appeal, therefore, activists opted for political autonomy, a strategy with increasingly limited success in France's polarized political climate.

Meanwhile, motivated by moral fervor, activists sought to prevent the construction of nuclear power plants through site occupations and disruptive confrontations. These culminated in a mass demonstration that attracted some 60,000 people to the Super-Phénix fast breeder reactor site in Creys-Malville in 1977. The violence at this demonstration, in which hundreds were wounded and one killed, alienated many constituents. The media, initially positive in its coverage of the movement, thereafter began to focus on its violent aspects and the roles of leftist radicals and professional troublemakers. This backlash undermined environmentalists' efforts to mobilize public support and caused significant internal dissent. As a result, the movement entered a new phase in 1977, expanding its strategies to include conventional political participation and nonviolent actions.

For example, antinuclear activists sought alliances with consumer groups and other national and international associations. Using the expertise of scientists in the movement, they launched technical arguments to challenge the safety of nuclear plants and dramatize the problem of nuclear waste disposal. They organized a national rate-withholding campaign, asking people to deduct 15 percent from their electricity bills. As the political wing of the ecology movement, the activists increasingly engaged in electoral politics, sponsoring ecology candidates who won seats in many municipal councils. Finally, they went to the courts in a series of unsuccessful efforts to block the construction of nuclear plants.

In general, France's highly centralized political system provides few channels for effective public input on national policy. And on nuclear power in particular, aside from the pro forma public hearings required to obtain a construction permit, local or regional groups have no mechanisms by which to insert their objections into the decision-making process. France is the only "Western" country (defined by membership in the Organization for Economic Cooperation and Development) with no legislation specifically governing the development of this technology (*see "How Prometheus Came to Be Bound: Nuclear Regulation in America," by Michael W. Golay, June/July, p. 29*).

Thus, the French government has continued to dismiss criticism. Moreover, the antinuclear movement has lost much of its impetus in the wake of increasing unemployment and the public's mounting fear of economic crisis. The definitive electoral victory of the presidential majority in 1978 destroyed the hopes of many ecologists for a more sympathetic leftist government. Frustrated by their consistent lack of influence, members of the movement have increasingly turned inward to elaborate the movement's theoretical perspective — a tendency reinforced by the ideological polarization endemic in French politics. In this context, expansion of the nuclear program proceeds apace, relatively unfettered by political opposition.

Dorothy Nelkin is professor and Michael Pollak is research associate in the Program on Science, Technology, and Society at Cornell University. Professor Nelkin and Dr. Pollak are sociologists who have made extensive studies of citizen participation in a number of controversial technological decisions. They adapted this article from their book, The Atom Besieged: Extra-Parliamentary Dissent in France and Germany *(M.I.T. Press, 1980).* □

of the process. These "start-up" problems will be taken care of shortly, according to the company.

Cogema also concedes that its initial economic projections were overly optimistic. Experience with highly irradiated oxide fuels has led the company to revise its 1974 cost estimates by a factor of ten. Privately, officials admit that even these revisions are highly uncertain, since the true costs of reprocessing will not be known until operation at maximum annual capacity is achieved. (The plant is still operating on an intermittent, "batch-at-a-time" basis.)

But this issue may not be as serious to the program's future as it may seem from an American perspective. Since plutonium produced at La Hague will ultimately be recycled in breeder reactors, the French government feels its value must be determined relative to the advantages (including nonmonetary ones) expected from the breeder program. The official view in France is that short-term economic considerations are only one element, not necessarily the most important, in assessing the long-term advantages of a significant reduction in uranium imports that would be derived from successful breeder reactor development. Cost overruns

Letter from the Movement

Technology Review *asked*
Brice Lalonde, director of Friends of the Earth of Paris and a leader of France's ecological movement, to give us his view of the nuclear/antinuclear situation.
His letter follows:

The key point about the nuclear program in France is raised in Bupp's article: how far the French nuclear program goes will depend on the distribution of political power in French society. Technical issues are secondary.

Technical difficulties do exist, which the government insists can easily be overcome, but the antinuclear movement in France is not convinced. Information is tailored even for those closely involved in the program. Last year, the government was forced to admit that the first series of reactors coming into service suffered from cracks. The EDF management was not informed by Framatome (the builder) until one year after the cracks were discovered. The Council for Information on Electronuclear Energy, which the government set up with a fanfare of trumpets under the popular minister Simone Veil, only learned about "the affair of the cracks" one year after that, when the CFDT leaked the story.

There has never been a debate and a vote in Parliament on nuclear power. De Gaulle's famous constitution (1958) is so conceived that the construction of 200 reactors is a mere administrative matter: members of parliament play no part!

In France, decisions come from inside a huge administrative machine. Indeed, nobody on the outside knows how decisions are made. There might be debate, but we know as much about it as we know about what goes on in the Kremlin.

The first point at which the public is officially notified is the so-called public enquiry. Despite its name, it is not a judicial hearing. It is the bargaining process for compensating landholders when, for example, the State wants to build a new road, but it is totally inappropriate for such questions as the construction of a nuclear plant.

Here are two examples that show how little the public interest is considered. At Nogent-sur-Seine, 100 miles east of Paris, over 50,000 people turned out to oppose the construction of a nuclear power plant during the public enquiry. Only a handful supported it. The plant, of course, is going ahead. At Golfech, in the southeast, the local authorities, seeing what happened at Nogent, refused to allow an enquiry. A local referendum showed large-scale opposition. The elected councils of the department and the region voted against the construction. In the face of this opposition, the government still imposed the public enquiry procedure, bringing in the documents under police guard in lorries baptized "mairies annexes" (temporary city halls) for the occasion. To show their contempt, elected councillors even committed a crime under French law — they tore up the enquiry papers.

Consider the "battle of Plogoff" early this year. For six weeks, virtually the entire population of this little village in Brittany resisted the police, who, with the support of the army, were imposing another of these public enquiries. And because an important issue was centralization versus decentralization, people throughout Brittany became involved.

The French nuclear program is not only the result of a technocratic tradition supported by tough institutions. It is also a symbol of the last successes of what was until a few years ago the national consensus. Supported by the Gaullists on the one hand and the Communists on the other, this consensus emerged after the Second World War, precisely when the French Atomic Energy Commission and the Central Electricity Board were created. These publicly owned organizations were supposed to be virtuous

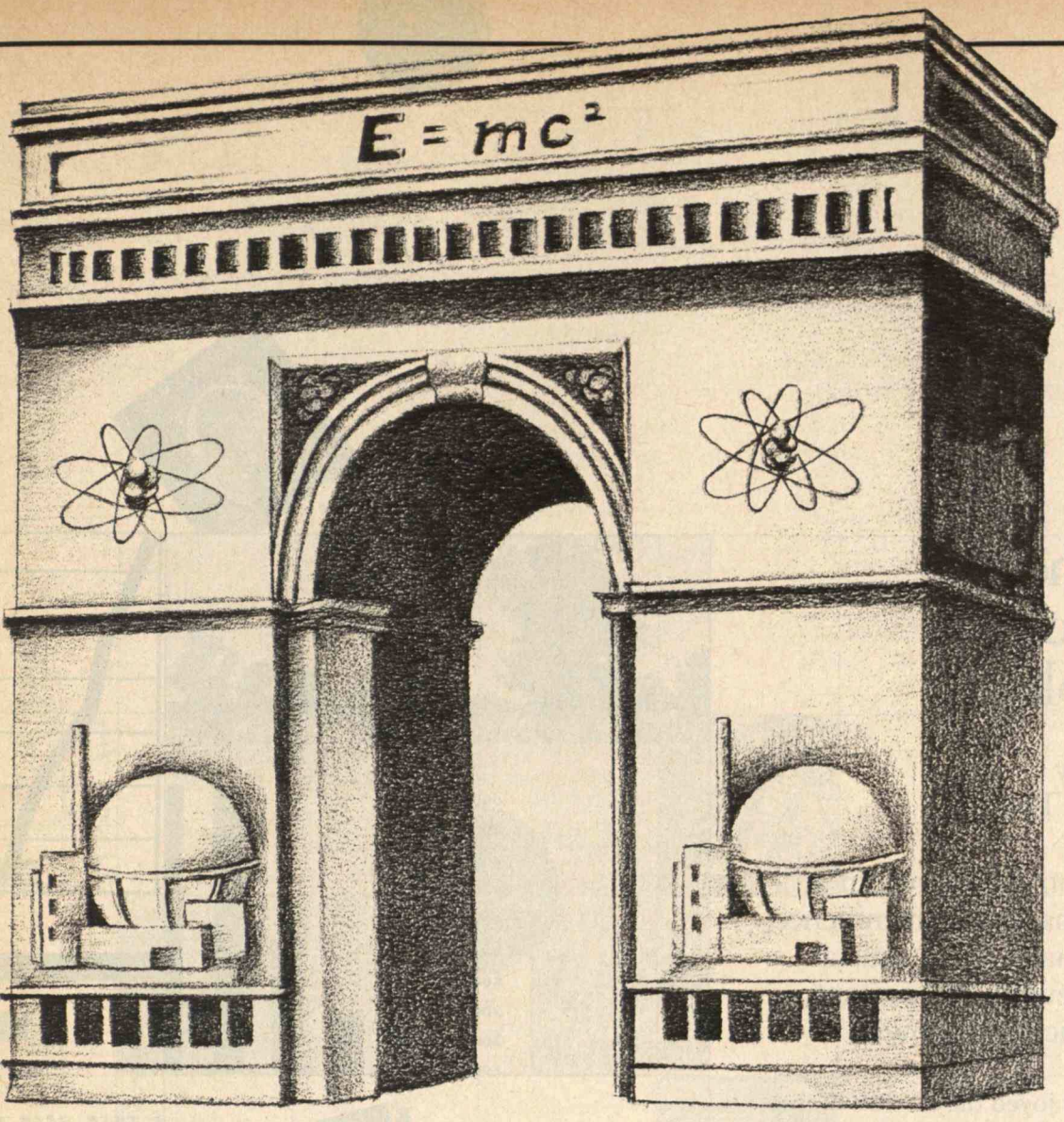
at La Hague may not be important given the enormity of the stakes.

Independence Depends on Interdependence

What is an outside observer to make of all this? Because of the thoroughness of government control, there is a lack of independent data for assessing the technical validity of official statements. And even though CFDT's strength among scientists and technicians in government clearly gives the union an inside perspective on the program's progress (or lack of it), the union's political — even ideological — goals are equally clear. It is therefore very difficult to judge its allegations.

Moreover, getting La Hague to work is the ideal type of problem for the French system, since it involves technically based problems insulated from major economic and political constraints. Technical difficulties, whether related to plumbing or basic process chemistry, must be overcome, but those with the mandate to do so have the resources for a massive, concentrated assault. They also have some strong incentives: La Hague buys time for Cogema's foreign customers to continue the construction of the LWRs that constitute those countries' short-range energy policies. It is important to understand the nature of the real deal between Cogema and the governments of Japan, West Germany, Sweden, Switzerland, Belgium, and the Netherlands. In effect, these governments are giving Cogema front-end capital and accepting an apparently open-ended, longer-term financial risk in return for a five-to-ten-year grace period to launch their own nuclear programs.

The really basic question is whether France, more or less alone, can proceed through the 1980s in pursuit of the nuclear dream. Can France establish the industrial and financial base for hundreds of years of energy from atomic fission? No one knows, of



because they were not running after profit but were devoted to public service and pure "technical matters." One could sum up the consensus in three sentences:

☐ What is important in a society is to produce.

☐ What enlivens a society is the State.

☐ What identifies a society is the nation.

Even if this consensus is now ending, no political force yet clearly expresses the new values: certainly not Mr. Giscard d'Estaing, who is personally involved in the nuclear industry, or the Socialist Party, whose members are mainly civil servants. So nuclear power still appears to a lot of French people as a way to keep up with high growth rates and to be proud of French international leadership.

But the future in France belongs, I believe, to the ecological movement, not to the nuclear lobby. ☐

course, but the answer will likely have little to do with narrow technical questions about the tractability of reprocessing, breeder technology, or even long-term radioactive waste management and disposal. Rather, it will depend on whether the distribution of political power in French society, and the values that currently control French life, can be maintained.

It will also depend on developments outside France that those in charge of the French nuclear program have little power to influence. The revolution in Iran was an especially pertinent example: the loss of reactor sales to Iran has been a heavy blow to the French nuclear industry. Framatome — France's partially nationalized, and only, reactor manufacturer — has but one foreign customer (South Africa), and prospects elsewhere are not bright for the immediate future. EDF can keep the company busy for a while longer, but government officials admit that France's domestic market cannot indefinitely sustain the six-reactor-per-year demand to which Framatome's manufacturing capacity is geared.

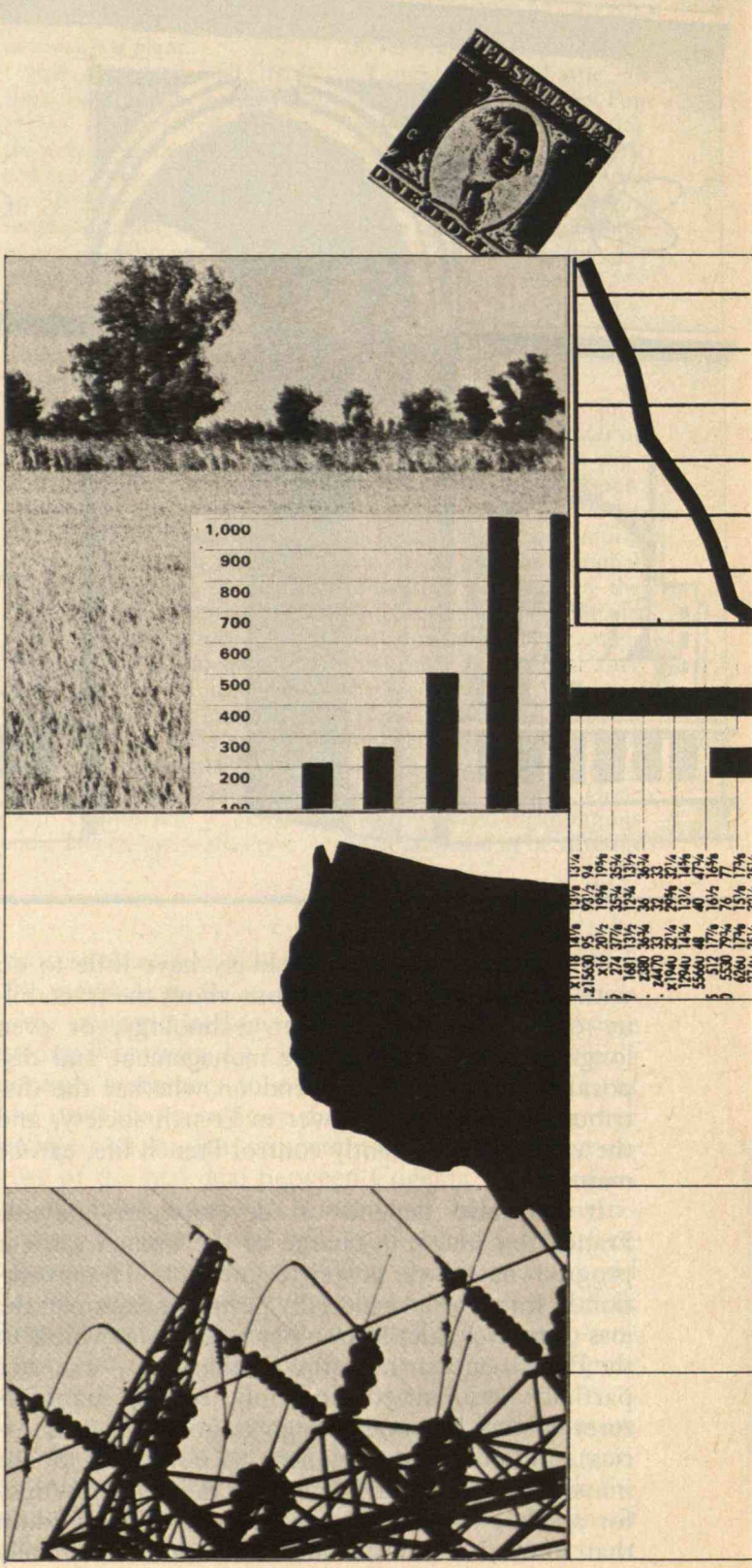
Ultimately, the problem is more general. A major pillar of the entire French nuclear development effort is the expectation of significant long-term export markets on all fronts: for nuclear power plants, uranium enrichment, and fuel reprocessing. If much of the non-Communist world turns away from nuclear power, both the pace and the scope of the French program will almost certainly require profound revisions.

Irvin C. Bupp is associate professor of business administration at the Harvard Business School. He is coauthor, with Jean-Claude Derian, of *Light Water* (Basic Books, 1978) and, with Robert Stobaugh et al., of *Energy Future: Report of the Energy Project at the Harvard Business School* (Random House, 1979). Professor Bupp is executive director of the Keystone Radioactive Waste Management Discussion Groups, a three-year-old project in Keystone, Col. to promote cooperation between the pro- and antinuclear communities on waste disposal. This article is based on a report prepared for a conference at Keystone last year.

The Productivity Problem

by
Lester C. Thurow

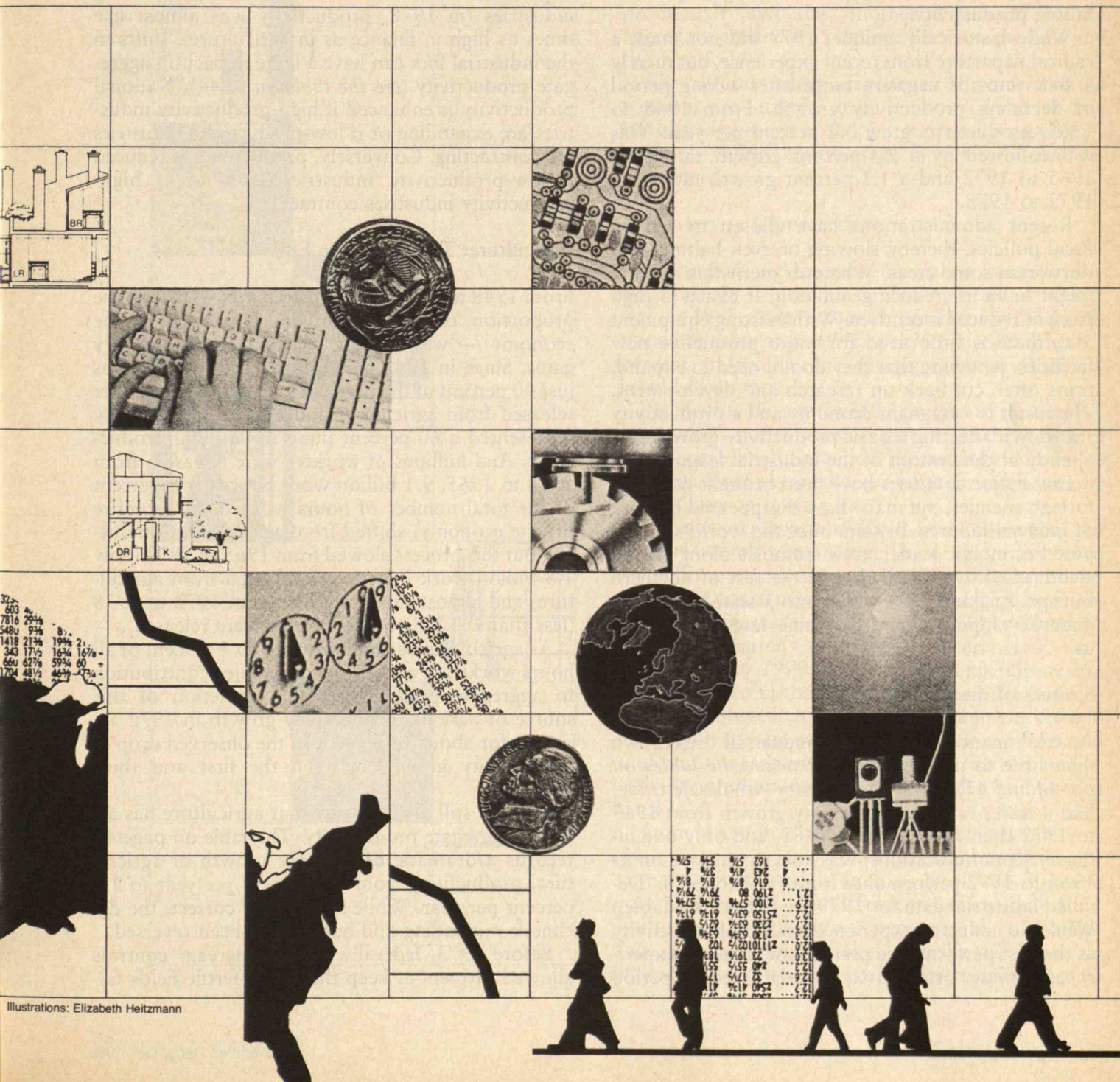
If the U.S. economy is to return to a position of international prominence, Americans must make some crucial compromises to reverse the present decline in productivity growth.



Not long ago Americans enjoyed the world's highest standard of living. Today our position is no longer so lofty — rich Middle-Eastern sheikdoms aside, we stood fifth among nations in per-capita gross national product in 1978, and our standing continues to slip. Switzerland, Denmark, West Germany, and Sweden are all ahead in the great GNP race, and Japan, the world's fastest economic runner, is gaining at a rate more than twice ours. While it can be argued that this "catching up" of other countries is in some ways desirable, the prospect of the United States sliding into a position of relative backwardness is not.

Integral to this slowdown in U.S. economic growth is a sharp decline in productivity growth. Productivity — output per hour of work — is the ultimate determinant of our real standard of living. Americans can only consume what they produce — if we produce less, our standard of living must fall, since there are simply fewer goods and services (including leisure) to divide.

Productivity fell 2.1 percent during 1979 — at year's end, the average American worker was only 97.9 percent as efficient as at the beginning. This



Illustrations: Elizabeth Heitzmann

Few major countries have been brought down by foreign enemies, but many have disappeared because of internal failures.

decline would not be a source of concern if 1979 had been a recession, since productivity often declines when output is falling (workers are not laid off as fast as output falls), but 1979 was not a recession. Real output was growing, if only slowly, and the current recession did not begin until early 1980. Therefore, 1979 was unique in American economic history: it was the first year with rising output and falling productivity.

While historically unique, 1979 did not mark a radical departure from recent experience, but merely a shift into the negative range after a long period of declining productivity growth. From 1948 to 1965, productivity grew 3.2 percent per year. This was followed by a 2.3-percent growth rate from 1965 to 1972 and a 1.1-percent growth rate from 1972 to 1978.

Recent administrations have chosen to tighten fiscal policies, thereby slowing or even halting production in some areas. Whatever merit this method might have for reducing inflation, it exacts a high price in reduced incentives. With existing equipment idle, there is little need for more productive new facilities. Knowing that they do not need to expand, firms often cut back on research and development. The result is a stagnant economy and a productivity slowdown affecting a basic productivity growth rate already at the bottom of the industrial league.

Few major countries have been brought down by foreign enemies, but many have disappeared because of internal failures. Britain, once the world's undisputed economic leader, now stumbles along with a standard of living half that of the rest of northern Europe. England has entered into a state of relative underdevelopment, and the same fate could befall us.

Sources of the Decline

An examination of a detailed industrial breakdown does little to mitigate the gloom (*see the tables on pp. 44 and 47*). Only one industry (wholesale trade) had a faster rate of productivity growth from 1965 to 1972 than from 1948 to 1965, and only one industry (communications) was able to improve on its 1965-to-1972 performance from 1972 to 1978. (Detailed industrial data for 1979 are not yet available.) While no industry experienced falling productivity in the first performance period, one industry experienced falling productivity in the second period (construction), and in the third period this industry was joined by another (mining).

However, an industrial breakdown does allow us to begin to analyze the sources of the decline in productivity growth. Particular industries' problems can be isolated, but it is also important to look at the effects of shifts among industries. Since there are large differences in the levels of productivity among industries (in 1978, productivity was almost five times as high in finance as in agriculture), shifts in the industrial mix can have a large impact on aggregate productivity (*see the table on p. 44*). National productivity is enhanced if high-productivity industries are expanding or if low-productivity industries are contracting. Conversely, productivity is reduced if low-productivity industries grow or if high-productivity industries contract.

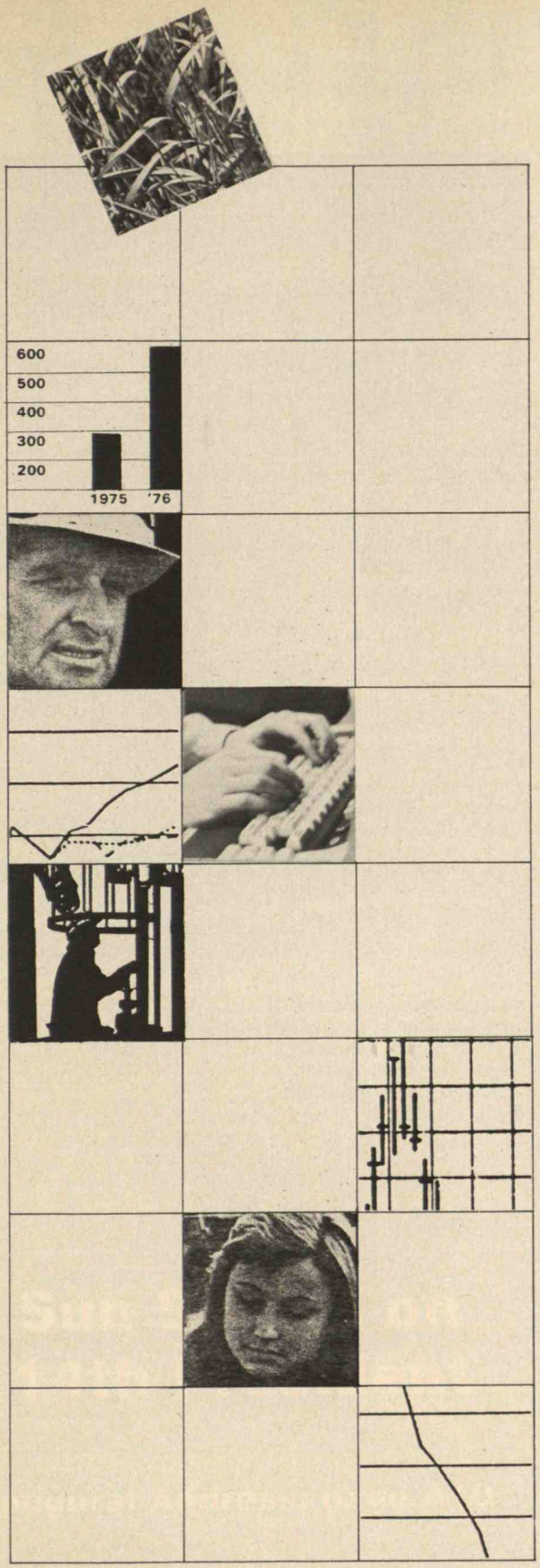
Agriculture: The End of an Era

From 1948 to 1965, the industrial mix — that is, the proportion of various private industries in the economy — was shifting to enhance productivity gains. Since in 1948 agriculture's productivity was just 40 percent of the national average, every worker released from agriculture and retained by industry represented a 60-percent jump in national productivity. And millions of workers were released: from 1948 to 1965, 9.1 billion work hours (or 8 percent of the total number of hours worked in the entire private economy) shifted from agriculture to industry. But this process slowed from 1965 to 1972 (only 1.8 billion work hours were released from agriculture) and almost came to a halt from 1972 to 1978 (less than 0.1 billion work hours were released).

As agriculture declined from 17 to 5 percent of all hours worked, it actually made a major contribution to aggregate productivity. The depletion of this source of national productivity growth in 1972 accounts for about 14 percent of the observed drop in productivity growth between the first and third periods.

There is still another way that agriculture has affected aggregate productivity. The table on page 44 records a dramatic drop in the growth of agricultural productivity from 5.0 percent per year to 1.7 percent per year. While statistically correct, the decline is misleading and has already been reversed.

Before 1973, federally imposed acreage controls allowed farmers to keep their least-fertile fields fal-



low, but when those controls were discarded in response to grain shortages, millions of low-productivity acres were replanted. This structural change and the concomitant corn blight caused productivity to fall by 4.5 percent that year. By 1974, productivity returned to 1972 levels, and agricultural productivity has since grown faster than from 1948 to 1965. But this temporary dip in agricultural productivity explains another 3 percent of the aggregate productivity decline between the first and third periods.

Agricultural factors account for 17 percent of the national productivity decline. Some of this decline has already been reversed, but most is irreversible — it simply marks a new stage in our industrial development.

A Mystery in Construction

Construction productivity has fallen continuously since the late 1960s and is only 79 percent of what it was in 1965. If construction productivity had continued to grow at its 1948-to-1965 pace, another 17 percent of the decline in aggregate productivity would disappear.

To identify the source of 17 percent of the decline, however, is not to cure 17 percent of the problem. The decline in construction productivity is a major mystery. Since no one knows what caused it, no one knows how to reverse it.

Various explanations have been advanced but none is entirely convincing. The problem may even result from errors in measuring the industry's output. Since construction does not produce a homogeneous output, it is difficult to measure (*see "Innovation in Residential Construction" by Francis T. Ventre, November 1979, p. 50*). Dollar expenditures on construction must be deflated by some price index to yield real output. And if some government statisticians overestimate construction inflation, others will underestimate construction output, thereby underestimating productivity (output divided by hours of work).

From 1954 to 1977, construction output was thought to have been up 58 percent, but the use of construction materials such as steel and concrete rose 133 percent. It's difficult to believe that 1977 buildings take twice as much material as 1954 buildings. The government makes extensive use of private indexes of construction costs in calculating its own

price index. If the government estimates are wrong, then we must assume that major builders and major users of construction do not really know what it costs to construct a building.

Alternatively, construction productivity may have become bogged down in the fights over nuclear generating plants (a major part of construction), or may simply be a reflection of shifts from the building of simple interstate highways such as those crossing the wide-open spaces of Kansas to rebuilding the West Side Highway in New York (which requires millions of miles of wires and pipes to be moved before construction can even begin). While there is no doubt that construction is a major part of the national decline, there are many doubts as to what can be done about it.

Hitting Rock Bottom

Mining productivity in 1978 was only 77 percent of what it was in 1972, and the reasons for this decline are as clear as those in construction are mysterious. Approximately 80 percent of the answer is found in oil — the major mineral "mined" in the United States. America has simply reached a stage of geological depletion. Production is falling in old oil wells, and new wells yield less oil per well drilled. Consequently, it simply takes more hours of work to produce a barrel of oil.

The remaining 20 percent of the explanation is found in the mining of other minerals in the United States. Here environmental protection and occupational safety probably play the major roles in decreasing productivity, for there is little evidence of rapid depletion. If open-pit mines have to be filled and the land restored to its natural contours, more hours of work are required to mine a ton of coal. If better ventilation and more tunnel supports are required to protect underground miners, more hours of work are necessary to mine a ton of copper.

While mining accounts for 10 percent of the national productivity decline, only about one-fifth of this decline is controllable. The rest, a blow from Mother Nature, must simply be tolerated.

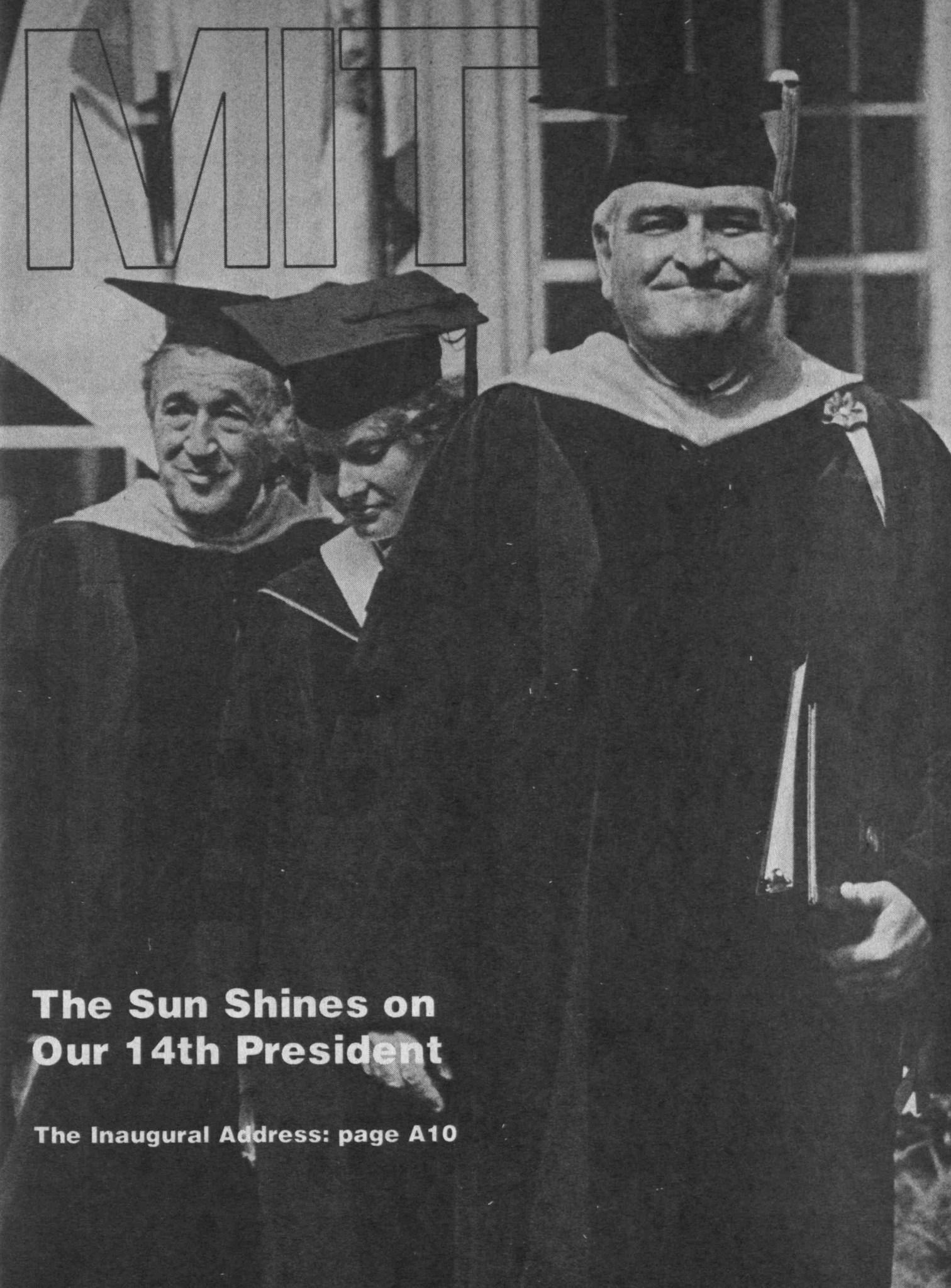
Lights Out

While productivity growth occurred in electrical and gas utilities from 1972 to 1978, there were declines in two years (1974 and 1977), and average produc-

Industry	1948–1965	1965–1972	1972–1978
Agriculture, forestry, fisheries	5.0	4.1	1.7
Mining	4.3	2.4	-4.2
Construction	3.4	-1.8	-1.8
Nondurable manufacturing	3.3	3.2	2.6
Durable manufacturing	2.8	2.3	1.2
Transportation	3.1	2.4	1.7
Communications	5.4	4.5	6.8
Electricity, gas, sanitary services	6.3	3.4	1.3
Wholesale trade	3.2	4.0	0.0
Retail trade	2.6	1.8	1.2
Finance, insurance, real estate	2.0	0.8	1.1
Services	1.2	1.6	0.7
Private business economy	3.2	2.3	1.1

The table above shows the percent change in productivity growth of private industry. Overall productivity growth decreased steadily over this 20-year period.

MIT



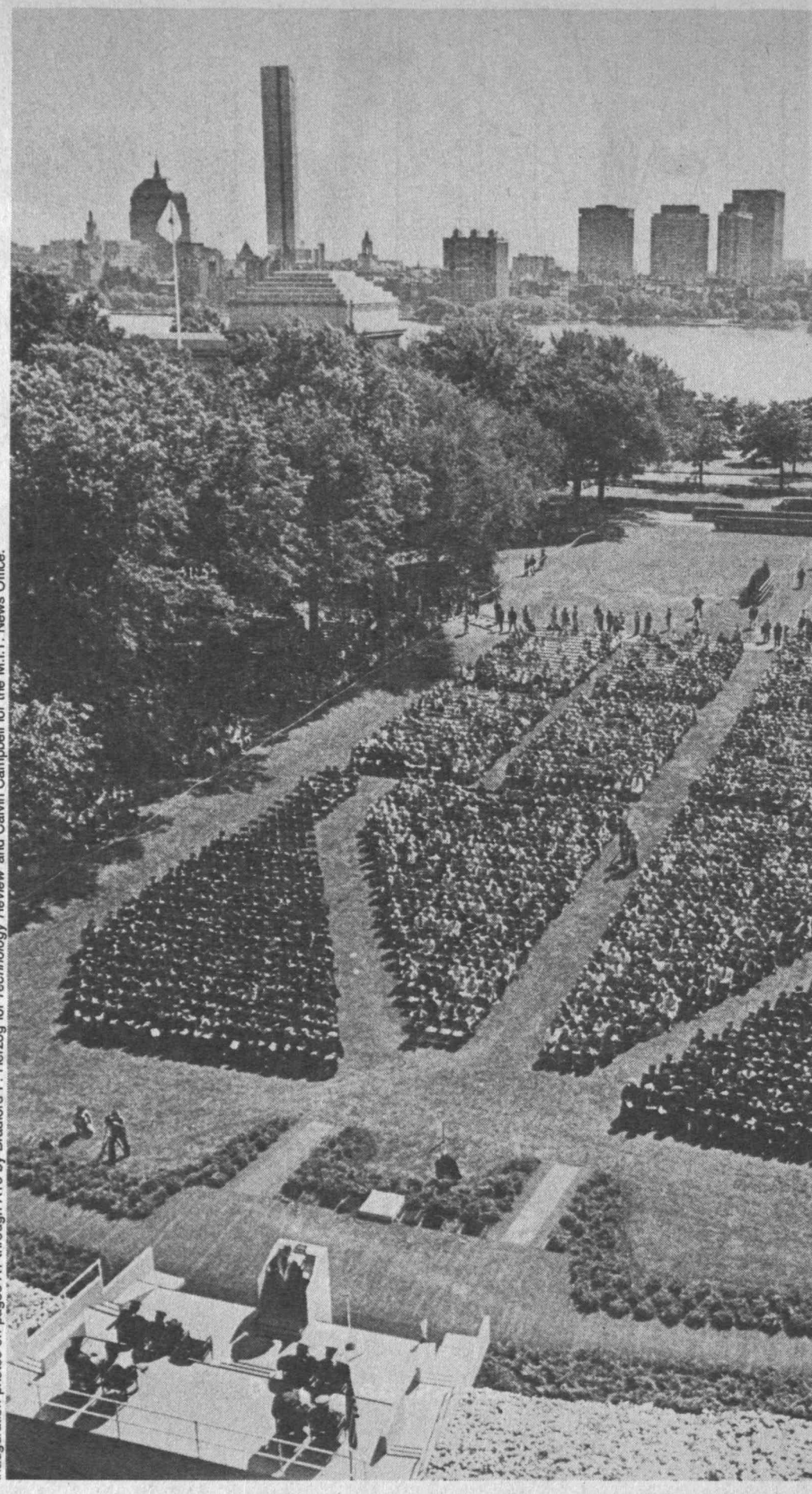
The Sun Shines on Our 14th President

The Inaugural Address: page A10

The Inauguration: The Sun Shines on Paul and Priscilla for Four Very Special Days

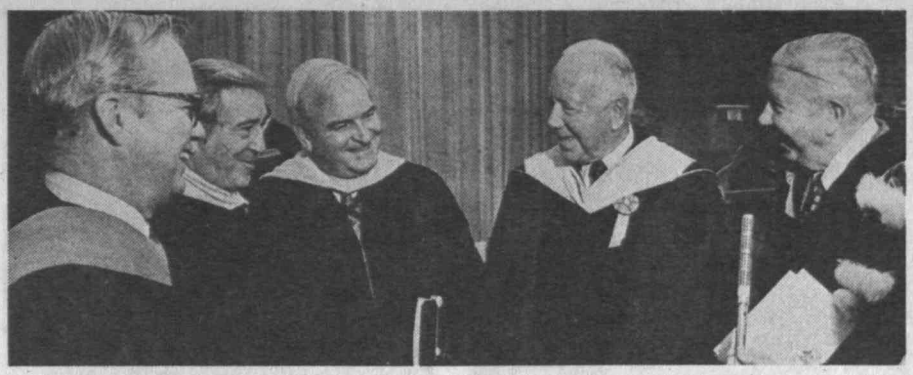
It is of course not given to bricks, sandstone, concrete, and the mortar that holds them together to glow with pride. But the illusion was almost inescapable. For during the four days of celebrations at the end of September for the inauguration of Paul Edward Gray, '54, as the Institute's 14th president, all those associated with the Institute — and even, it seemed the buildings themselves — shared a radiance born of joy and confidence in past, present, and future.

"Paul, the sun shines upon you!" said James R. Killian, Jr., '26, concluding his own tribute at the beginning of the formal ceremony on Friday, September 26. And it did — quite literally at that moment as clouds dispersed, and figuratively through four days that have no recent parallel in Cambridge.



Inauguration photos on pages A1 through A16 by Bradford F. Herzog for *Technology Review* and Calvin Campbell for the M.I.T. News Office.

Cover: *Following his investiture and inaugural address, President Paul E. Gray, '54, leaves the platform in Killian Court (right) on September 26. Behind him are his daughter, Virginia Wilson Gray Army, and his predecessor, President-Emeritus Jerome B. Wiesner. (Photo: Calvin Campbell)*



In no other American university does a president have the hazard of living with four predecessors in situ, *quipped Howard W. Johnson, chairman of the Corporation, as he opened the Inauguration Exercises on September 26. Left to right, preparing for the ceremonies: Mr. Johnson, Jerome B. Wiesner, Paul E. Gray, '54, Julius A. Stratton, '23, and James R. Killian, Jr., '26.*

"The Corporation is Convened . . . a Day of Celebration"

The air is soft, gentle; the sky is grey, the Prudential half disappeared in the mist, Boston muted, trees dark and heavy with lingering drops, the ground damp. Zero wind: Killian Court is very still, waiting. Then suddenly, "six, six, six, six . . . come down a little bit . . . one, two, one, two, check . . ." A voice tests the powerful sound system, its speakers on towers that almost dwarf the regal columns. Technicians lean over dials intently. Around them, people materialize from everywhere to wipe up puddles, put programs on chairs, work with video cameras. Musicians are tuning up. A constant hubbub of sound.

The sky is growing lighter. The lawn is a carefully arranged sea of chairs, brightly colored string between sections, ushers carefully directing throngs of guests. Now the Choral Society is singing as Killian Court fills. The air begins to move. The light is changing by the minute, as if a stage electrician is adjusting a bank of dials. Clouds thin, thicken, seem almost to break, and then return.

Over 6,000 people from far and near are here, come to pay their tributes to Paul Gray, to revel in the pageantry of the Institute, to express their joy and confidence in new leadership and a new decade. Familiar faces, waves and greetings everywhere.

Now ushers — all classmates of Paul Gray's Class of 1954 — bring in the Gray family. Suddenly the waiting is over, the music swells. Professor Sheila Widnall, '60, as chairman of the faculty, shepherds her flocks, two by two — the Corporation, delegates from 150 academic institutions and organizations, members of the faculty and staff, representatives of graduate and undergraduate students, and alumni leaders. "The Corporation is convened . . . a day of celebration," declares Howard W. Johnson, chairman of the Corporation.

A prayer for her parents and for the institution which her father now leads, from Virginia Wilson Gray Army, a senior at the Yale Divinity School: ". . . support and guide them with wisdom and courage as they embark on this new commitment . . . to maintain the intellectual vigor and moral sensitivity which have become the hallmark of this institution."

"Total Immersion . . . Completely Indigenous"

Intoducing Dr. Killian, M.I.T.'s tenth president, Mr. Johnson notes that he is "the oldest member of the largest club of ex-presidents *in situ* in the country's institutions of higher education." (A hazard for Paul Gray, opines Mr. Johnson: "four former presidents looking over his shoulder.")

"You are uniquely an M.I.T. product," Dr. Killian tells Paul Gray — "total immersion. No past Institute president was so completely indigenous.

"May it come to pass that in the future, men will make of your presidential days, to use an Homeric metaphor, stories for singing," says Dr. Killian.

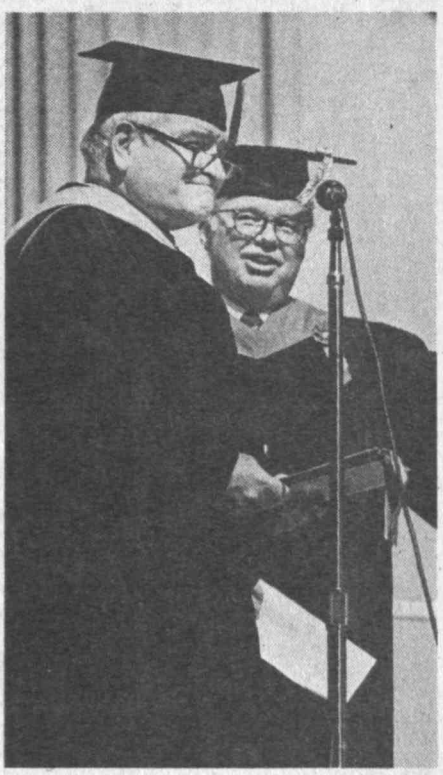
And as Dr. Killian says these words the scudding clouds part and Killian Court is flooded with light and color. A moving, prideful moment to which no one in that jubilant throng could be insensitive.



A President in Free Flight

Presented with the Charter, Paul Edward Gray responds: "I pledge myself to work unremittingly . . . for the greatest good of this institution."

Then he *ad libs* a moment: "I've been asked how it feels. . . . I guess I feel a little like the human cannon ball at Ringling Brothers. It was fired two days ago, and I'm now in ballistic free flight, somewhere near the apogee. I can't influence the trajectory at this point; all I can do is have faith that those out there somewhere have a big net."



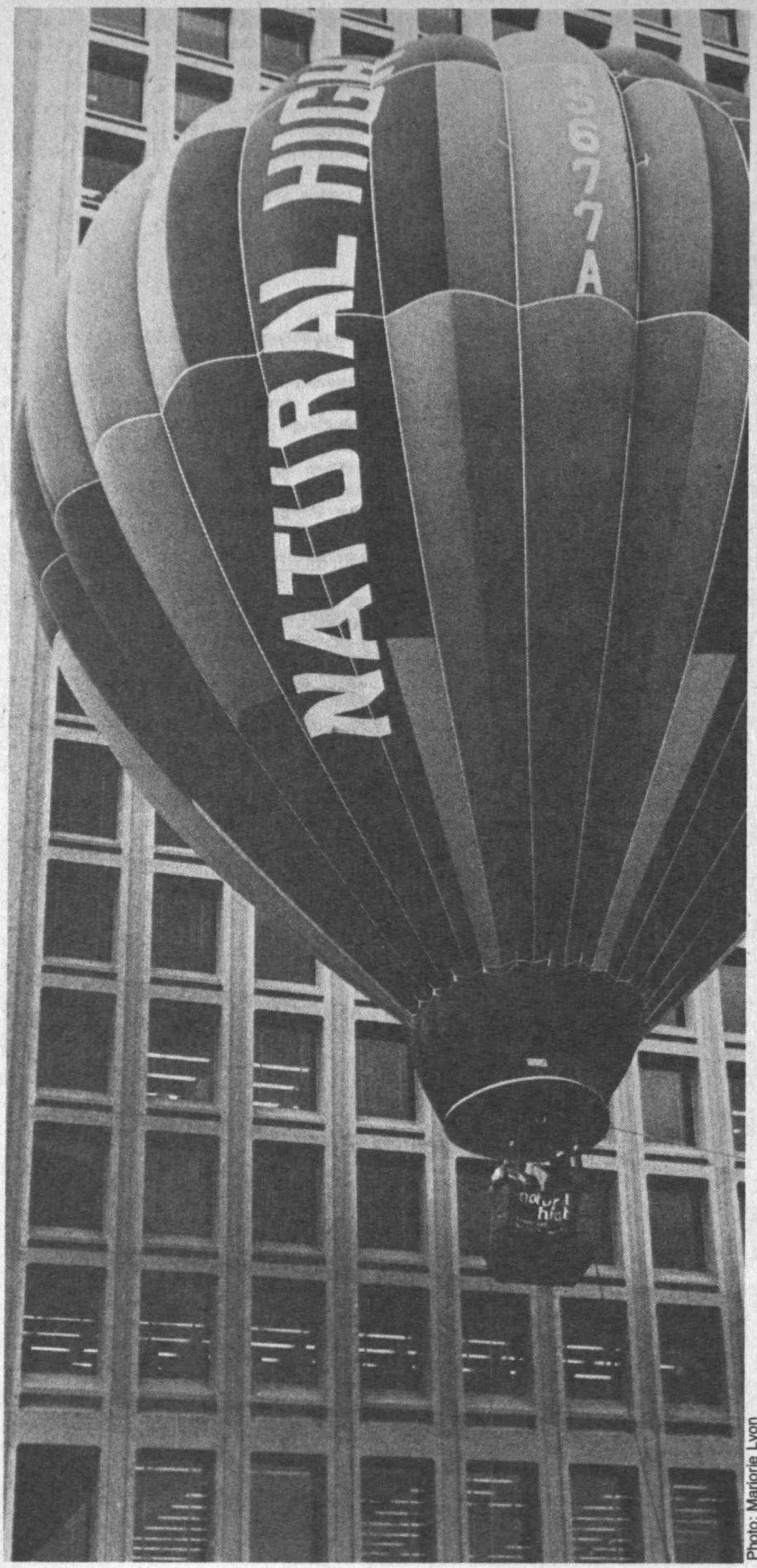


Photo: Marjorie Lyon



Photo: John Mattill

Seduced by a Jubilant Beat

Walk into McDermott Court on Wednesday afternoon, and it is hard to believe one's eyes. The sky is clear, the air brisk. A large part of the M.I.T. community is here.

The first of 275 official entries and an unknown number of "ringers" lope across McDermott Court to finish a four-mile race around the Charles. The winner is Sumner Brown, 66 of Draper Laboratory, electrical engineering, in 20 minutes and 1 second; as he crosses the line amid cheers, a huge bouquet of balloons is released to fill the sky over the main buildings for a brief moment in the chilly September air. Hot dogs, cotton candy, dixieland jazz: the throngs tap their feet and are seduced, delighted, to dance to the jubilant beat.

A hot-air balloon — "Natural High" in large letters on its side — floats in front of the Green Building, its ribbed red, black, and yellow magnificence holding up a basket stuffed with people. They peer and wave with delight at the crowds below — including a small child who waves back frantically, neck bent, eyes big.

(I stood in line, freezing, for an hour, and it was well worth the wait — transported by magic, it seemed, to hover and sway above the campus. A spectacular view of the Charles and the city across the river as darkness brought out the first city lights).—*M.L.*





Experts on energy: Pierre Agrain (back to camera) joins fellow-panelists (left to right) Charles J. Hitch, Professor Francis E. Low (moderator), and Professor John M. Deutch, '61, in an ode to large-scale technology.

Music Everywhere

Paul and Priscilla have told the committee that they hope music can have "an important part" in the inaugural celebration; and they want M.I.T. people making some of it.

It does, and they do.

On Thursday there is music everywhere; every student group is singing and playing in the corridors at noon — the Logarithms in Building 10, the brasses in Building 7, the Chorallaries in Building 6 — a jubilant, celebratory dialogue which verges on, but never quite reaches, a cacophony.

That evening the Inaugural Concert in Kresge Auditorium: music by Beethoven, Mozart, and finally the stirring celebration of Cesar Franck's Quintet in F minor. To play this concert the Roumanian String Quartet makes a special trip from Ireland — and welcomes into its midst two of M.I.T.'s own: Professor Marcus Thompson (viola) for Mozart's Quintet in C major and Professor John Buttrick for Beethoven's Trio in D and the Franck. Professor Kenneth Hoffman salutes the members: their long trip to Cambridge, their program, and their welcome to Professors Thompson and Buttrick, are together an act of "selflessness" that may be fully understood by only a few in the audience, he says.—*J.M.*

The Inaugural Ball: M.I.T. Transformed for an Evening

A ball it is — Lobdell Student Center's second floor is jammed with party goers, the cafeteria totally transformed with balloons forming great archways above dancers, a band playing rock music.

There are other choices for different tastes: one has only to wander to the other side of the building to find a laser light show in a darkened room, dancers swaying in a solid mass to a big-band swing sound. They are oblivious to the crush.

There was more. Just brave the chilly clear night air for a moment and venture to du Pont where in the gym (yes, it feels like a prom) festooned with even more balloons, one can ballroom dance or just boogie.

Guests represent all facets of the M.I.T. community, from freshmen to senior faculty and staff. A single big family has turned out in its best duds to celebrate. Thousands are here — I can't think of another occasion that would entice so many of the community to celebrate together. It is a party of parties, and a great tribute to Paul and Priscilla Gray.— *M.L.*



Will Mankind's Light be Dimmed in a World-Wide Brownout?

Three symposia on Wednesday and Thursday are described by visitors as "the best they've ever heard" at M.I.T. Picturing the power of computers, Professor Marvin Minsky of M.I.T. describes "a future so bright you will need sunglasses." Technology has almost no limits: "if we had courage," says Professor Minsky, "we could have lunar colonies and self-replicating factories on the moon in 20 years."

Not quite, replies Harvard sociologist Daniel Bell, making a strenuous objection; such a future is "not a question of courage but of social priorities." Professor Bell has already warned of the changes that new technology will demand from all of us — "a vast change in the nature of symbolism," a revolution in the communications infrastructure that links our societies together. Who will control the systems, and how will people relate to them? he asks, without answering. Of all these questions, that of privacy is "the most pressing" of the new computer age, says Professor Michael O. Rabin of Hebrew University, Jerusalem. We ignore it at our peril, he warns.

Three panelists are unanimous in placing their faith in large-scale technologies — synthetic fuels, enhanced recovery, and nuclear fission leading to magnetic fusion for future energy supplies. The only question is whether the U.S., or any other industrial society, can make decisions in time.

France, says Pierre Aigrain, the nation's secretary of state for research, has two clear advantages: a single centralized utility and massive government involvement in the energy sector. In contrast, Charles Hitch, president emeritus of the University of California, finds U.S. utilities hamstrung by consumer-minded public utilities commissions which deny utilities the capital they need to invest in the future. John M. Deutch waxes enthusiastic about the newly created Synthetic Fuels Corp.; it will in the next decade provide a "wide range of technologically diverse synthetic fuel plants of commercial scale" from which the nation can then select for the future. But it will take time and patience; "the system craves fast solutions" which it cannot have.

The flowering of food science in the 20th century may not be the blessing it seems.



Greetings to Paul and Priscilla Gray from a record 2,410 well-wishers at luncheon in the new Athletic Center after the inauguration. Among those present: Derek Bok (right), president of Harvard University, and Dr. and Mrs. Gerald P. Dinneen (below). Dr. Dinneen, formerly director of Lincoln Laboratory, is now assistant secretary of defense for research and engineering.



Our foods are so energy-intensive that we almost literally "eat oil for breakfast," says Professor John Hawthorn of the University of Strathclyde at a symposium on food and hunger; and (because the less-developed nations "worship the gods we have created") the rest of the world will do so as soon as it can. If energy resources are running out, energy-intensive foods will soon enough have to give way to . . . what?

Sir William Henderson of the U.K. and David Pimentel of Cornell agree: we cannot return to an obsolete past; we need a future based on everything — human, animal, fossil, and alternative (solar and wind) energy.

To Transform the Institute With "Richness and Variety"

In his Inagurual address (*see page A10*), Paul Gray rededicates himself to "quality and vigor" in engineering, science, the humanities, the arts, and the social sciences — "dimensions of intellectual and creative experience . . . necessary to the definition of M.I.T. as a university devoted to the broad reach of human inquiry."

But, he says, we must "transform M.I.T." in three ways:

☐ Attend "to the humanistic elements and the human consequences of all that we do."

☐ Adjust our "high-pressure environment" to provide "more time for contemplation . . . for developing friendships and a sense of community."

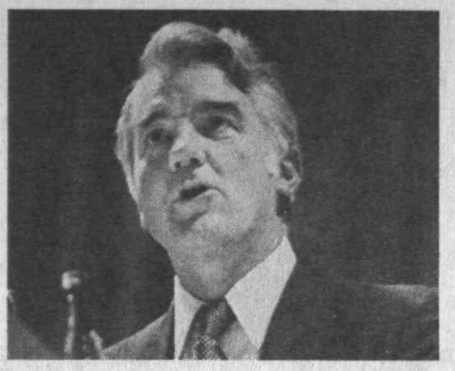
☐ Place "issues centered on the human condition . . . at the top of our agenda.

"I cherish a vision of a time and a place — our time and this place — where the richness and variety we seek in our community will become a reality. I ask all of you today to help make this our joint achievement — now."

There are interruptions for applause, and there is a standing ovation as Paul concludes for Priscilla and himself: "We feel that we belong here, and we are ready to go to work with you."



Photo: John Mattill



Enlightenment and Statesmanship, But This Is No Sleek Yacht

Very large and spanking new — with that feeling that debris left from last minute construction had just hurriedly been swept away — the athletic center's indoor track plays host to a big and jubilant crowd. Indeed, it was the largest assembled luncheon ever held at M.I.T.: 2,410 guests seated at 250 tables in an area the size of a football field.

Greetings to President Gray:

☐ *From President Jimmy Carter* (by telegram): M.I.T. is a "major national asset"; Mr. Carter is confident that the Institute is "at the threshold of even greater scientific advance," and he wished Dr. Gray "a satisfying and successful tenure."

☐ *From President Derek Bok of Harvard,* speaking for all the institutional delegates: Time now to replace the generation of scientific leadership nurtured in World War II with new leaders whose task looms larger than ever before in the face of "pervasive public skepticism. . . . M.I.T. will be a source of enlightenment in the wise use of science and technology."

☐ *From Professor Sheila Widnall, '60,* for the M.I.T. faculty: Drawing on the metaphor of sail, with which Ms. Widnall and her husband are expert, she warns Paul that M.I.T. is by no means "a sleek yacht with a well-disciplined crew all pulling in the same direction." Rather, she says, we are "a cross between a square rigger and Noah's ark, with sails on every yardarm and at least two of everything on board." But she pledges that the faculty "will be true to you in our fashion." And for herself, "I will be in your corner fighting for you and with you to enhance the Institute's commitments to excellence, education, and equity."

☐ *From Charles Markham, '81,* president of the Undergraduate Association, for the undergraduates: We are heartened by your interest in students and your desire to help them. But Mr. Markham raises one topic on which the new president has thus far been silent: the need to keep costs low.

☐ *From Sharon Lee,* president of the Graduate Student Council, for the graduate students: Though we are students of science and technology, we are committed to "peace and human rights. . . . May your presidency proclaim and clarify that sense of . . . purpose."



☐ *From Harl P. Aldrich, Jr., '47,* president of the Alumni Association: The alumni "lobbied quietly for your selection," Dr. Aldrich tells Paul, we're confident in our expectations, and "we pledge to you our continuing support."



Alumni as "the Success of M.I.T."

As the shadows lengthened on his inauguration day, Paul Gray with Priscilla on his arm walks slowly home across the campus to 111 Memorial Drive, there to receive the personal good wishes of more than 3,000 alumni, faculty, and guests — some of whom wait patiently more than an hour to gain entrance to the President's House. The Grays are glowing, tireless, proud.

To alumni among the guests Paul emphasizes that the warmth of their greeting is a very special treasure. That fact had been clear since a few minutes after dawn that morning, when Paul and Priscilla had foregone breakfast with the Corporation to join more than 450 alumni having breakfast (at 7:30 a.m.!) in Walker Memorial.

"The alumni — you — are the success of M.I.T.," Paul says in a brief greeting.

Priscilla, "not far from tears" by the wealth of their welcome, tells alumni that she and Paul share "a sense of awe and humility when we see so many who have come so far to share this best of days with us."

The new beginning has begun. — *M.L., J.M.*



An Inauguration Week Diary: ". . . thinking about what we are, what we mean, and where we are going . . ."

by Steven Solnick, '81

Monday, September 22, 5:30 p.m. I was just rained on in front of the Student Center. It seems they were hosing the place down to clean it up for all the joyous festivities. I didn't see the sign on the door.

I was nearly sandblasted on the steps of 77 Mass. Ave. earlier this afternoon.

I scampered away in the nick of time to avoid being steamrolled on the Great Court yesterday.

Yes, it seems there's some sort of inauguration afoot.

Tuesday, September 23, noon. A trip to the Inaugural Committee. I wait patiently as six phones are answered by two people, one of them the Chairman of the Inaugural Committee, Professor Kenneth Hoffman. "Oh, she will be able to attend. How lovely. Excuse me for a second. Professor, it's Monsieur Aigrain calling from Paris again. Now, sorry, we will have confirmed reservations at the Ritz for . . ."

I slip quietly out the side door wondering what I was getting myself into by accepting an invitation to march in the Academic Procession.

Then it came to me. Gowns, silly. I was getting myself into gowns.

Tuesday, 4 p.m. I've just been showing a few people around our spacious campus.

When we got to the Great Court, my train of thought was lost completely.

Chairs. Everywhere chairs. Thousands and thousands of folding chairs. In two colors, black and yellow. With symmetrical aisles converging at the front center where there is a . . .

. . . mountain. There's a god damn mountain in the front of the Court. It wasn't there this morning. There was just an innocent grey platform.

In six hours they buried the defenseless platform. And moved in enough chairs for the Second Coming. And a sound system to boot. Better than Woodstock, almost (we're not flashy but we're efficient here at Tech). They must be getting ready for a visitation. Or at least a Sermon on the Mount. With a real mount!

Tuesday night. Sometime, I'm not sure when. In all the frivolity and mind-numbing anticipation of the Gray event, I forgot about the ten-page paper due in six hours. Or four. Soon.

A friend just called to say he'd ordered his tux for the Inaugural Ball and I'd better get mine cause they're going fast. Some friend. I hope he's the only person under 45 sporting a tux.

Wednesday, 6 p.m. It was too gorgeous an afternoon to stay on campus so I spent it at Harvard Square.

I collapsed onto my bed when I got home. In just a few short minutes, my neighbor came into my room, mouth hanging wide open. He pointed incredulously out the window and stammered, "Uh, look, look. A thing."

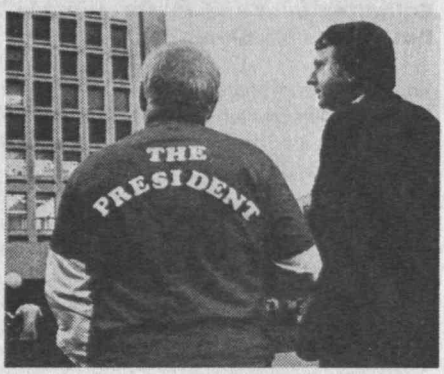
Not grasping the totality of his message at once, I turned and glanced out the window. And there it was. Hovering at about the height of the Great Dome but right in front of the Green Building.

A purple striped hot air balloon.

My natural curiosity (and enthusiasm for hot air) took me quickly enough out to McDermott Court. The M.I.T. Classic Road Race had just ended and the Court looked like a hyperventilation convention. Red T-shirts matching red faces. I don't know who won. I noticed immediately, though, that there was a line for free hot dogs, so I joined it.

The Man of the Hour, Paul Gray, was wearing a red Road Race shirt which bore the inscription "The President" across the back. Everyone there, even certain students and administrators who took misanthropy as their physical education requirement, seemed to be having a good time. Gray kept boasting about how much fun the ride in the balloon had been. Everyone was agreeing with him. I didn't get to ride in the balloon and felt very left out.

Some oaf behind me asked very loudly



whether anyone felt this was all worth $20 per person, citing the price tag inaccurately quoted in a student publication. A senior standing next to me turned defiantly and said, "Yes. It sure is. How often does something like this happen anyway?"

I had to agree with him.

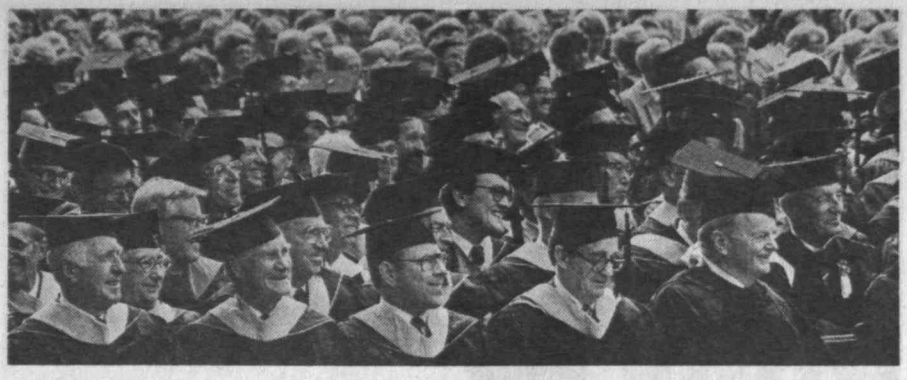
Wednesday late night. I don't believe what they did to the mountain in the Great Court. It's covered with little flowered bushes. All over it. Like a floral arrangement for a Don Ho special. The sound system is mind-boggling. The whole scene was bathed in a blue fluorescent glow and I was reminded strongly of what the Common looked like the night before the Pope came to Boston.

Thursday, 11 a.m. The Vice-President came to M.I.T. today. But he didn't upstage Paul Gray.

When Gray, Wiesner, Low, and Killian entered Kresge through the side doors down front, they seemed somewhat startled by the spontaneous applause which greeted them. It started with just a few people clapping, in the same way an M.I.T. audience will sometimes applaud stagehands during an intermission just to embarrass them.

But as more and more people joined in, it became a genuinely warm greeting for the school's leadership. The audience seemed to sense this shift as well, and there was an almost noticeable wave of goosebumps crossing the crowd.

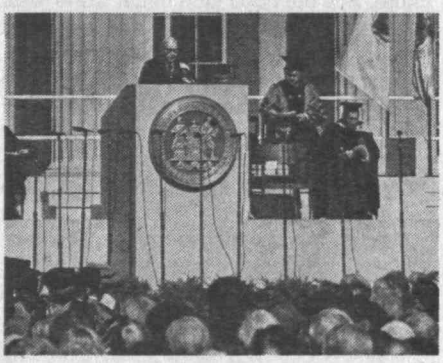
A staffer in the News Office told me that he thought people just wanted something to feel good about at M.I.T. again and that the whole Inaugural Week was sort of serving that purpose. It's a view I'd heard elsewhere.



It seems Paul Gray might have found a new image, these last couple of days. He's starting to be viewed as a bit more friendly and a bit more open than much of the student body perceived him after last year's students-rights flaps. It's an image he seems much more comfortable with and one that suits him much better. Truer, too.

Thursday, 9:30 p.m. I haven't been to class in three days, and I'm not planning to go tomorrow. It doesn't feel like a school any more. Everyone is talking about purpose and direction and leadership and national needs. I feel like I'm at something much more *vital* than just a school. It feels like an important *university*. What a concept.

Right now, though, I just want to decide what to wear tomorrow. I'm too tired to think.



Friday, 10 p.m., after everything. It's all over. There's the Paul Ball tomorrow night but I'm not going to write about that. I intend to just drink and have a good time.

It was sure one hell of a day, though. If I'm this tired now, I'd hate to see the shape the Grays are in right now.

The scene in du Pont was like something out of the Chicago stockyards. Seven hundred or so people in colorful gowns, herded into little pens by their last names and their titles. Administrators from all over the world.

"The Procession will begin at approximately 10:44," came an amplified voice. I'm glad they weren't *too* approximate.

Then we were moving. Very little warning. Absolutely no instructions. Just follow the marshals.

There were about 50 undergrads. We felt horribly inadequate as the front of the procession passed us looking like something out of *A Man for All Seasons*. Every color of the rainbow and shape in the universe. And us in black choir robes. We huddled to pass the time and decided to keep our tassles after the episode was over.

Out onto Mass. Ave. We made some wild gesticulations to the Dudley bus which was stalled by the spectacle. Music was coming from somewhere.

A student behind me criticized our lack of decorum as we posed for pictures. Another beside me expressed his fear that someone he knew would see him.

I had to admit I felt a little silly, too. I figured everything would become much more solemn when we got to the Court. I turned to wave at a friend who had recognized me and almost knocked down the mate who was fearing for his anonymity. Nearly made quite a spectacle.

At the Court I picked up a flyer being handed out by some protesters. They were wearing signs which said, "M.I.T. is a bad neighbor." I didn't want them to think we were inhospitable, too.

Suddenly we were headed up the center aisle and the principals were shaking hands on the right. I pressed the flesh with Paul Gray, two former White House Science Advisors and the mayor of Cambridge in the space of 30 seconds. It was not until I headed through the audience that I realized that it's not something that happens every day.

The line broke into a brisk walk through the audience. I was a little disappointed at this, since I wanted to savor the moment some. Then I decided I would savor all I wanted in June during my Commencement. That would be my day. Now I was just filling in the ranks of a highly extraordinary procession. I trotted along.

As we took our seats, I turned around and noticed a vast empty section in the audience. Due mostly to what appeared to be a fairly low student turnout.

I felt a true rush of embarrassment right then. On behalf of all the students. But mostly I was embarrassed by the ones who had scrawled "education not coronation" in some corridors around this place.

Once every ten years or so, M.I.T. does something not as a teaching center and not as a research center but as an institution. Inaugurations are not *for* students, or faculty, or alumni, or even presidents. They are for the institution and all that it means.

This week was devoted to thinking about what we are, what we mean, what our role is, and where we are going. Here, "we" does not mean students or faculty. "We" means M.I.T., that 120-year-old institution which has played such a large part in the history of this country and has meant so much to so many different people.

It obviously didn't mean that much to the "education not coronation" crowd because they were denying themselves the opportunity to even consider the prospect of having some real feelings about M.I.T. They are a selfish, sour-grapes crew. They're probably just the types who object to the circus because the smell of animals offends their delicate balance. They should all be rounded up and fed to the lions.

I almost overdosed on history later in the afternoon as I watched James Killian through a sea of mortarboards. My eyes shifted slightly to Killian's right and I read: "This Court is Dedicated to James Ryne Killian . . ." A former president speaking in a grandiose court named after him. These people are figures in history. And they were all president once. And they were all sitting in front of me. I wondered what Gray might do to earn a building or a court in his honor.

The actual investiture was the most anticlimactic thing I'd seen since Evel Knievel and the Snake River jump. "Here's the Charter." "Thanks." Not in so many words, of course.

And that was the investiture. But the events of the week thus far had already achieved the focus of energy I had expected to see at that moment. What did I expect?

The Inaugural Address was upbeat and very encouraging. I kept wanting to applaud, but Gray never seemed to wait for applause. A friend told me later she had wanted to cheer parts of the speech wildly but was intimidated by the passive response of the crowd, like people who go to a circus but refuse to laugh, on grounds of principle.

To hell with them, I said, and applauded frequently.

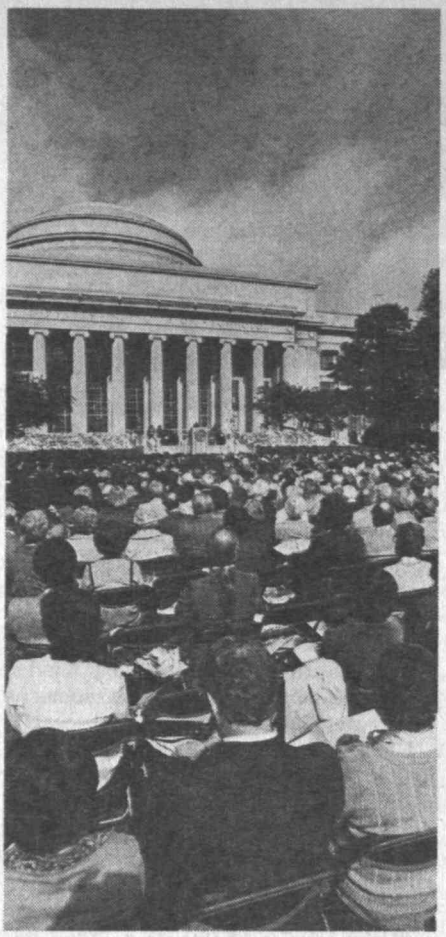
I marched more slowly on the way out.

We passed some people on their way to class as we crossed Mass. Ave. I have a lot of homework this weekend. Maybe I've got just a little more reason to do it now.

Steven Solnick is editor of The Tech.

The Inaugural Address: Preserving Our Focus and Transforming Our Programs

Following is the text of the inaugural address by Paul E. Gray '54, fourteenth president of M.I.T., on September 26, 1980.





I come to this lectern imbued with many — and varied — emotions and feelings. This position is, for me, the culmination of a lifetime of intimate association with this extraordinary institution. As student, alumnus, member of the faculty, and administrator, most of my adult life has centered on the surroundings of this courtyard. I stand here today as no stranger to you, and the Institute is a central part of my life. The dominant emotions I feel are those of profound respect and humility, for this place expects and deserves uncommon performance from those who are privleged to serve it.

With me on this platform today are the four men who have served as president of the Massachusetts Institute of Technology during 30 years of my life here. I owe much to each of them, because their legacies of devoted stewardship and because of the support and encouragement they have given me. They have provided continuity and wisdom through the many M.I.T. generations — years which have seen enormous changes in the nature of science and technology as well as in the character of the Institute. I am particularly indebted to Jerry Wiesner, with whom I have worked so closely during the years since he became president in 1971. His generous sharing of the accomplishments, and the problems, of his presidency has provided me with an extraordinary apprenticeship. Words fail to express my indebtedness.

Technology in the Service of Humankind

My purpose in these remarks is to express my sense of the mission of M.I.T., particularly as we look to the challenges and the opportunities of the 1980s.

As M.I.T. enters a new decade, it takes its place in a world whose prospects for peace and justice are uncertain — a world in which economic security, literacy, and health are *not* enjoyed by most people. With all of our progress, poverty is still the only prospect, and hunger a condition of life, for a shockingly large portion of the world's people. Even in the most advanced countries, such as our own, driving inflation and painful levels of unemployment strain the society and cast shadows on our dreams.

Here in the United States, in the midst of a presidential election year, there is a widely shared sense that many of the old values and ways are not appropriate to these times. And yet the political process has not produced new paradigms for addressing the problems of our age. Some suggest that the political process itself, including the structure and the organization of our government, is unable to respond effectively to the complexity of our world and to the shrinking scales of time and distance.

Earlier in this century people looked to science and technology to light the path of progress. This is no longer the case. That early, and somewhat naive, optimism has been replaced by a skepticism and by an alarming decline in scientific literacy in this country. This decline reflects, in part, the difficulty of keeping up with fields which grow and change with astonishing speed. But there is also, among the public, an ignorance, wariness, and discomfort about most things scientific and technological. Such an attitude *must* be of great concern to us here, for we have an essential responsibility to make the case for science and technology in the service of humankind. M.I.T. is — and should be — expected to provide leadership for improving the level of scientific literacy and for nurturing talent in — and for — today's world.

Probably the toughest questions we face today have to do with the social and political context of the decade ahead. I venture no political or economic predictions. My ability to divine the future complexion of our society and of our economy is no better than yours. There are no easy answers, and there may be no sure path to finding any answers. There is one certainty, however: the young men and women who entered the Institute as freshmen three weeks ago *are* the future. And our hope for a better world rests just as surely with them — and with what they learn here — as it does with the discoveries and advances in knowledge to which our faculty contribute. Our challenge, as we chart our future course, is to set our priorities and to forge educational and research programs that will bring that hope closer to reality.

Meeting this challenge requires, I believe, that we both *preserve* and *transform* M.I.T.: we must preserve its historic intellectual focus and its insistence on excellence; and, at the same time, we must transform its programs to serve the needs of the future.

The Spark for Achievement

I would like to speak first of the special character and distinctive purpose we must preserve as our touchstone for the future. We are a science-based university which places special emphasis on education.

We must preserve our unswerving commitment to the quality and vigor of our core activities in engineering and science. We must do so in ways that respect the integrity of basic science; in ways that uphold the values of applied science and technology; and in ways that reflect and engage the social context in which science and technology occur.

We must preserve and continue to build strong programs in the humanities, the arts, and the social sciences. These dimensions of intellectual and creative experience are necessary to the definition of M.I.T. as a



university devoted to the broad reach of human inquiry. And they are essential to our providing a full and balanced education for our students.

We must preserve our emphasis on education. We have a responsibility to educate our students for civilized leadership as professionals and as citizens of the world. Our responsibility to them, and to the generations that will follow, is: to support them in the development of their intellectual powers; to help them shape their values and attitudes toward increased caring and compassion; and to encourage their personal growth as creative, sovereign human beings.

The emphasis on education, however, cannot be sustained without the research strength of the Institute. Our efforts to push out the frontiers of knowledge — to seek answers to the basic questions — are fundamental to the life of this institution. Research at M.I.T. inspires, nourishes, and helps to organize all that occurs in this academic community. It provides the basis for graduate and postgraduate education and contributes in powerful ways to the development of the creative abilities of our undergraduates. The active involvement of students in research adds fresh perspective to the research enterprise. And it reminds us once again of the curiosity, the enthusiasm, and the stamina which provide the spark for innovation and achievement.

We must, therefore, preserve research and education as complementary activities on this campus. Indeed, I would say that the blending of research and education *defines* M.I.T., and our future must continue to rely on their combined strengths.

I believe, therefore, that in contemplating any new research opportunity or program, we must ask, each time: How will it contribute to our capacity as an educational institution? What benefits or opportunities will it bring to future generations of students? And, in turn, we must ask: How will new educational programs challenge the imagination of the faculty — the men and women on whom we rely for institutional growth and renewal?

Science and the Human Condition

I would like now to discuss some ways in which we must *transform* M.I.T. There are, I believe, three related challenges which we must meet if M.I.T. is to sustain its leadership and influence in the decade of the 1980s and beyond. In setting these challenges before you, I am not suggesting that change at M.I.T. should be precipitous. But I do believe that we can — together — take the bold steps necessary to secure the Institute's future.



I. *We must rededicate science and technology as socially powerful activities.*

We continue to hear the complaint that the world has had too much of science and technology; that many of our human and social ills are the direct result of unanticipated and deleterious artifacts of technology, foisted upon the world by technicians with tunnel vision.

It is clear, however, that the future development, not only of this nation but of the world, is inexorably tied to continued scientific progress and to the humane and thoughtful applications of science. What is needed is not a retreat from science and technology but a more *complete* science and technology.

We must strive to develop among ourselves, among our students, and in the public at large an understanding of the fact that engineering and science are, by their very nature, humanistic enterprises.

Scientific inquiry is, at once, a most natural and a most highly refined expression of the human mind and spirit. It is derived from native curiosity about the nature of our world and about the universe, and it results in speculations and concepts which help to give meaning and order to that world. Engineering and technology are both natural and socially-derived enterprises. They offer suggestions of agenda — on goals and priorities — for scientific inquiry. And, as Sir Eric Ashby noted two decades ago, engineering must engage with the daily process of living. In his remarkable essay entitled *Technology and the Academics*, he said: "... a student who can weave his technology into the fabric of society can claim to have a liberal education; a student who cannot weave his technology into the fabric of society cannot claim even to be a good technologist."

Ultimately, I believe, this inquiry and these enterprises must rest where they begin, with concern for the human condition.

The attention to the humanistic elements and the human consequences of all that we do must be broadly shared. For not only do we need a more complete science and technology, we need to understand — and to engage — the larger social, cultural, and historical domains of which they are a part. We must continue to be a sanctuary for the constructive criticism of the technological enterprise and of the larger society. These principles must be built into the academic programs of our students — both undergraduates and graduates — and they must be reflected in the lives and activities of all who choose to be part of this institution.

The humanities, the arts, and the social sciences are essential to our efforts — as distinct intellectual disciplines, each with its own integrity, and as forces which develop a sense of time and place, encourage the arts of expression, and shape the values necessary to the complete education of our students. Indeed, a second challenge we face has to do with education at M.I.T.



II. *We should review the character of the M.I.T. educational experience, paying particular attention to the questions of pace, coherence, and intellectual impact.*

The young men and women who come to the Institute as students are highly motivated, able people who are committed to high levels of achievement and intellectual effort. They join an environment in which sustained hard work is the norm and in which sloth is the cardinal sin. The capacity and passion of our students for hard work reflect those qualities exemplified by the M.I.T. faculty.

This union between committed, hard-working people and an institution in which hard work is a deeply ingrained ethos produces, all too often, a frenetic pace of life — a pace which is self-rewarding and mutually reinforcing. And not without its costs. Most undergraduates regularly register for a remarkable — some would say staggering — number of subjects. Many faculty undertake heavy burdens of outside professional commitments, which, when superimposed on their responsibilities to the Institute and on their personal family responsibilities, produce a load which numbs the mind — and the body. M.I.T. reinforces these modes of behavior by rewarding those whose achievement is exceptional in a group where exceptional achievement is the norm.

Now it would be foolhardy for me to argue, in front of this audience of true believers, against the virtues of hard work. Rather, should we not ask, from time to time, about the side effects of this high-pressure environment? And should we not consider the possible benefits of more time for contemplation, for pursuing of interests and activities outside the professional realm, and for developing friendships and a sense of community?

The pace of M.I.T. contributes, I believe, to those centifugal forces which weaken our shared central purpose and which impair the coherence of our educational programs. We must take care that we have the time and the commitment to educate the *person* — as well as the future professional in a specific field. If M.I.T. is to achieve its potential as "a university polarized around science, engineering, and the arts," to use the phrase given by James R. Killian, Jr., as the Institute's tenth president, we must engage — in each new generation — in the task of redefining the meaning of a liberal education based on science. This task is central to our purpose and to our existence. We must face it head-on if we are to prepare young people for leadership in the world.

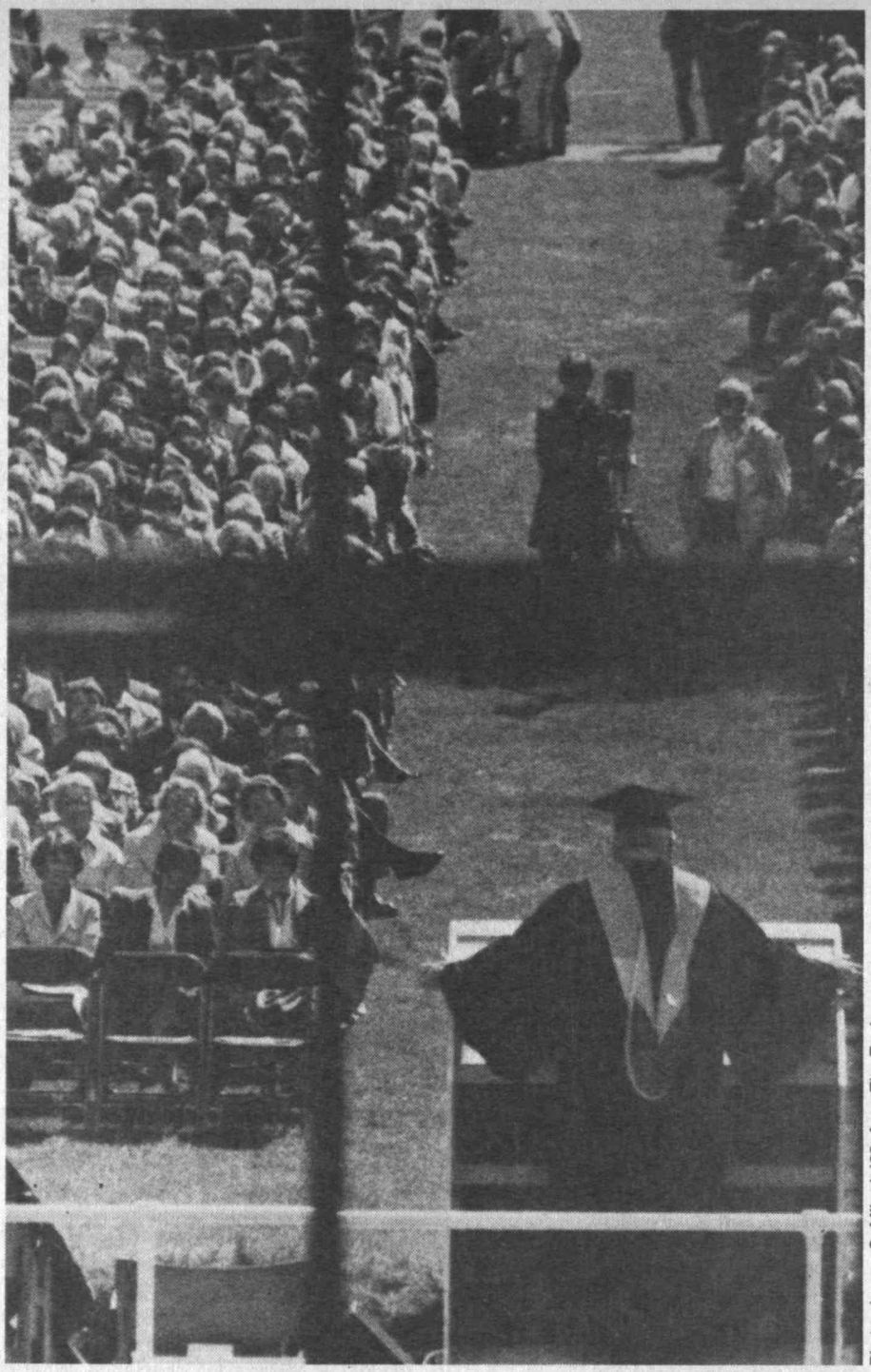
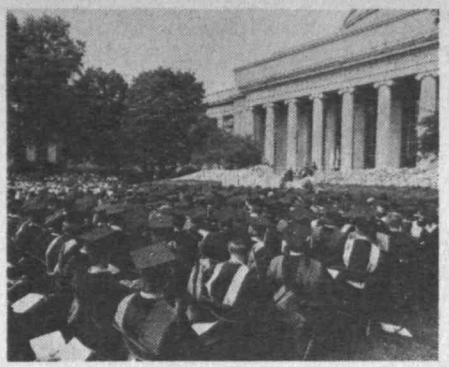


Photo: James C. Mihori, '83, from *The Tech*

For it is in the college years that students should learn to examine the basic premises about self and society, to explore different ways of thinking, to develop independent judgment, to sample and to relate diverse intellectual styles and concepts. These explorations form the cornerstone of later personal and intellectual growth and must not be bypassed in the interest of early specialization.

Our dedication to providing our students — particularly our undergraduates — with a full and balanced education is a major unifying force for this institution. And it is a force which would not exist if we were to concentrate solely on graduate education, on research, and on the advancement of the disciplines. The collective responsibility and commitment of the faculty to undergraduate education is, I believe, one of our most important and valuable assets.

It is not easy, however, for the faculty to maintain a collective resolve on this matter. The forces which pull us apart are strong, and some have been with us for a long time. For example, the increasing specialization



To Paul and Priscilla Gray, her parents, from Virginia Wilson Gray Army (right) in the Invocation to the Inauguration: ". . . Show them their path clearly so that with patience, compassion, strength of mind, clarity of purpose, and joy of spirit, they may have the wisdom to perceive the ways in which You reveal Yourself and Your holy will. . . . May this institution continue to meet the challenges . . . before it. Help us to maintain strong convictions and unrelenting faith in the face of all adversity."





of knowledge and the necessary development of strong disciplinary associations which transcend individual institutions inevitably impose limits on one's concern with internal institutional issues and with the holistic character of educational programs. Now the increasing complexity and runaway bureaucracy of the national system of research support limit the energy any one person can devote to institutional issues. It is important, I believe, for us to resist these forces of estrangement and to work hard to preserve a sense of community responsibility for, and participation in, the affairs of M.I.T.

This brings me to the third challenge which I set before you today:

III. *We should insist that issues centered on the human condition of the Institute be at the top of our agenda.*

The effectiveness, the achievements, and the influence of the Institute in the past have come from *people* — the tens of thousands of individuals who have cast their lots with this place. The successes — all the great contributions — of this institution rest on the extraordinary quality and effectiveness of individuals who, through their love of excellence, their intellectual powers, and their commitment to the first-rate, have made the difference.

Of course, it should be the same in the future, and it *will* be. But it may be more difficult. The quality of life in the academic setting does not seem as enviable as in the past. The pressures of inflation on salaries, the enticing offers for scientific and engineering talent in the marketplace, the bureaucratic snares which characterize many of our relations with the government — all take their toll. And while we are not alone in this respect, we may be more vulnerable than most universities.

I believe that we must give special attention to enhancing those qualities of the Institute which make it a good and satisfying place to study and work.

I am particularly concerned that we work to develop a community of the best faculty, students, and staff from as diverse a population as possible. For over a century, M.I.T. has been a place where exceptional people from all walks of life have come together to work and to study. As such, M.I.T. has a responsibility to itself and to the nation to be open — and to reach out — to the most talented and promising people, regardless of race or sex.

I am convinced that our own processes of selection, admission, and appointment meet the test of fairness. Nevertheless, we have not met our own objectives for making our educational programs accessible to minorities and to women, or for expanding employment opportunities to them. Our disappointment is evident in enrollments as well as in our record of employing women and minorities in professional capacities. We must, therefore, invent new ways of reaching those highly gifted people whose capabilities we have not fully tapped and



whose talents we have not previously nurtured. The patterns of prejudice, discrimination, and stereotyping in our society must be changed. And that change requires leadership from M.I.T.

It is our responsibility to help develop the full range of talent and potential in our society. Our success in meeting this goal can only be to our benefit — as an institution and as individuals. For a good deal of the learning at M.I.T. occurs informally, and is based on the daily interactions among people of different backgrounds, experiences, and points of view. Certainly the international character of this community has enriched the Institute over a period of many years. I believe the social and intellectual endowment of M.I.T. will be similarly enriched by growing numbers of women, and of blacks, Hispanics, and other minorities. It should be our goal to make this a welcome environment for them, to attract them in growing numbers, to support their growth, and to benefit from their creativity.

For the sake of M.I.T. and for the world we help to build, we would do well to share the vision of Margaret Mead, articulated nearly 50 years ago but no less relevant today: "If we are to achieve a richer culture, rich in contrasting values, we must recognize the whole gamut of human potentialities and so weave a less arbitrary social fabric, one in which each diverse human gift will find a fitting place."

I cherish a vision of a time and a place — our time and this place — where the richness and variety we seek in our community will become a reality. I ask all of you today to help make this our joint achievement — now.

A More Complete Intellectual Mission

While these, and other, challenges must be addressed in the years ahead, they represent, I believe, both great opportunities and cause for much optimism about that future. For each of these challenges is dedicated to a common goal: the creation of a more humane and a more complete intellectual mission, educational program, and sense of community at M.I.T.

Late in the summer our family moved from Winchester to take up residence at the President's House on Memorial Drive. In a few long days (and short nights) we have begun to develop a keener appreciation of the tempo of life on campus. We have — all of us — been cheered and encouraged by the warmth of the welcome we have received, and we are delighted to be a part of this extraordinary community. We feel that we belong here. And we are ready to go to work with you.



At home in the President's House. Almost as soon as they knew Paul would be president, he and Priscilla Gray decided to restore to its traditional use the President's House at 111 Memorial Drive. After a busy summer selecting furnishings and moving the family, Priscilla is ecstatic: "I'm delighted to begin to recognize everybody when I walk on campus," she told Joanne Miller of Tech Talk *this fall. (Photo: Calvin Campbell)*

A Tradition Is Restored as the Lights Return to the President's House

No small part of the pride that filled M.I.T. on September 26 when Paul E. Gray, '54, was inaugurated as 14th president stemmed from the joy which the Institute's new first family obviously takes in its new life.

Soon after Paul was named president-designate, he and Priscilla decided to restore a cherished presidential tradition: "We felt it was time to come back and be on campus," Priscilla explained to Virginia Bohlin of the *Boston Globe* this fall. And by Inauguration Day Priscilla was able to tell alumni at the Awards Breakfast that "we are at home in every sense of the word" in the President's House.

The truth of that statement was made abundantly clear at the end of the afternoon as some 3,000 alumni, faculty, and staff were proudly received in the familiar-yet-new surroundings of 111 Memorial Drive.

Already the Grays had entertained the members of the Class of 1984 and their parents at a reception early in September; all the residents of Senior House at a barbeque in the garden for which Senior House forms a grandstand; all the freshmen for whom President Gray is adviser — and the upperclassmen who have previously been his advisees; and the four former residents of the house — "Liz" and Jim Killian, Jay and Kay Stratton, Howard and Betty Johnson, and Jerry and Laya Wiesner. For the Inauguration the Grays hosted a houseparty of at least 22 — sons and daughters, parents, brothers and sisters.

Later on, says Priscilla, she counts on many more events for the community. "We have several ideas about ways to meet more students," she told Joanne Miller of *Tech Talk* this fall, and she only hopes that the presidential schedule will leave time and energy for them.

A major reason for the visit of the former residents was to show how Priscilla Gray had fulfilled her desire "to bring back into the house the people who had lived here." With help from Warren A. Seamans and his staff at Historical Collections, the study immediately to the right of the main entrance now contains photographs and small memorabilia creating virtually a family album of the house and all those who have occupied it since its completion in 1917.

Paul and Priscilla are fond of antiques, and the house reflects their preference — an English tall clock bought during a sabbatical in Ireland, Victorian parlor furniture inherited from Priscilla's grandmother, a Chickering baby grand piano on which all four Gray children took lessons. Rich use has been made of antiques and *objects d'art* from M.I.T. Historical Collections.

The Grays' family life — the four children are all away — centers upstairs, where Priscilla has a studio for work in embroidery and crewel (she is a graduate of the American Institute for Textile Arts at Pine Manor College). There's also a small kitchen on the second floor for private meals and snacks. The formal living and dining rooms on the first floor are little used except for parties and official functions.

After 20 years in suburban Winchester, the idea of moving into an Italian-Renaissance-style house with 15,000 square feet of floor space seemed "overwhelming" to Priscilla. And the first nights on Memorial Drive in August were "like trying to sleep in the Callahan Tunnel," she told Ms. Miller. But by September 27 Paul was discovering that relaxing by tinkering with the family car on Memorial Drive is not so different from doing the same thing on Sheffield Road in Winchester; only the kibitzers — Jay Stratton and some helpful undergraduates — are different. — *J.M.*

Mitchell Brook, '81, on Sources of Pride in M.I.T.

On September 26, the day of Paul E. Gray's inauguration, Mitchell Brook, president of the senior class, wrote in The Tech *some warm thoughts about pride in his alma mater:*

You feel school pride when you meet a linguistics student from Yugoslavia outside Room 9-150 who is travelling around America and she says that she is at M.I.T. because "M.I.T. is just so big. It's famous." This really happened.

Four years ago, William Lasser, '78, Editor-in-Chief of *The Tech*, wrote: "For the M.I.T. student, school pride does not come in the form of football victories or homecoming dances. Instead, M.I.T. students develop a satisfaction in their very survival. Life is no breeze here, but if you can make it, you can be proud of it."

Some things have changed since the days of William Lasser. In 1977, M.I.T. had neither a football team nor a homecoming. Now it has both. But M.I.T. does not recruit students merely for their football-playing ability as do Big Ten and Pac Ten schools. The football team is not called a "team"; it is called a "club."

In the last few years, the unofficial homecoming queen (king) has been UMOC — the Ugliest Man On Campus. And this year's homecoming dance takes place in Boston's unique ballroom, the Museum of Transportation.

Uniqueness is the stuff of which M.I.T. pride is made. In 1977, Bill Lasser hinted at the truly unique part of academics. Any student could tell you: "Courses here are tougher than those at any other school, Stanford and CalTech included."

By now, the freshmen should have begun to figure this out. The other day, I was sitting in Marty's room — he is a freshman who lives in my dorm. He complained, "Courses go so fast that we don't have time to think." Most upperclass students would agree that M.I.T. courses go fast and often go too fast. Eventually, new students like Marty become accustomed to that pace of life. As have most older students, they will conclude, with some amount of concealed pride, that "Tech is hell."

Many students have only a vague ap-

Right: *Winners of the Bronze Beaver — the highest honor for alumni service — for 1980 (left to right): Robert L. Rorschach, '43, Samuel A. Goldblith, '40, Harold Bugbee, '20, Philip K. Bates, '24, J. Robert Ferguson, Jr., '37, and Yaichi Ayukawa, '52.*

Below: *Greetings from Harl P. Aldrich, Jr., '47, president of the Alumni Association: "We are confident that . . . M.I.T. will further enhance its preeminence in science and technology in the service of humanity." (Photos: Bradford Herzog)*



preciation of M.I.T. rigor while they are at the Institute. When they work off-campus during the summer, however, they generally find that they are far better trained than students from other schools. While eating greasy peas at Walker, my friend Michael made the comparison like this: "The other guy from M.I.T. was OK, but the guys from Georgia Tech and other universities just didn't have the knowledge that we did."

Taking pride in the uniqueness and quality of M.I.T., as do most students, does not mean that the school cannot be improved. Freshmen are required to eat commons meals; there is much academic pressure; and there is crowding in dormitories.

But we can all look forward to the time when we are travelling in a foreign country, such as Yugoslavia, and a person we meet says, "M.I.T., I've heard of that."



Awards: Breakfast Honors for Alumni Service

The press of inauguration events allowed but one small, short remnant of the traditional Alumni Officers' Conferences in 1980, and time for that was even hard to find. But it was done, and an astonishing 450 loyal sons and daughters of M.I.T. and their guests — appeared at the hour of 7:30 a.m. on Friday, September 26, to honor their colleagues with the Alumni Association's growing roster of annual awards.

Paul E. Gray, '54, who was later that day to be inaugurated as 14th president, jilted the Corporation to join the alumni for breakfast; he could not break his record of ten consecutive alumni awards presentation, he said.

Top awards of the morning — six Bronze Beavers, the highest honors for service to M.I.T. bestowed by the Alumni Association — were given by Harl P. Aldrich, Jr., '47, president, to:

☐ **Yaichi Ayukawa,** '52, president of Techno-Venture Co., Ltd., Tokyo, who's been so influential in rebuilding M.I.T.'s relations in Japan that he's now Mr. M.I.T. of Japan to everyone.

☐ **Philip K. Bates,** '24, of Santa Monica, Calif., an alumni leader for over 50 years.

☐ **Harold Bugbee,** '20, of Winchester, Mass., a former president of the Alumni Association who's been secretary of his class for over 55 years.

☐ **J. Robert Ferguson, Jr.,** '37, senior vice-president of U.S. Steel Corp., Pittsburgh, participant in "a plethora of fund-raising activities" on behalf of the Institute.

☐ **Samuel A. Goldblith,** '40, vice-president — resource development of M.I.T., for his "energetic commitment" to alumni and their role in Institute affairs.

☐ **Robert L. Rorschach,** '43, of Process Technology Corp., Tulsa, Okla., for alumni service in every category.

There were four Presidential Citations for groups and activities in 1979-80:

☐ **The Boston Seminar Series,** a lecture series organized by a group of Boston-area alumni.

☐ **The Cleveland Symposium,** a day-long program on future technology organized by the M.I.T. Club of Cleveland in February, 1980.

☐ **The M.I.T. Club of Fairfield County (Conn.),** suddenly the strongest M.I.T. club in the Greater New York area.

☐ **The M.I.T. Club of Palm Beach County (Fla.),** after three years "a successful and viable presence."

New this year, Lobdell Awards (named to honor the memory of Harold E. Lobdell, '13, the first executive vice-president of the Association) were made to 13 alumni for "outstanding service" to a single alumni activity:

☐ **Edwin H. Baker,** '56, for the M.I.T. Alumni Center of New York and the M.I.T. Club of Northern New Jersey.

☐ **Allan S. Bufferd,** '59, for his class and to the Alumni Fund.

☐ **Charles H. Chatfield,** '14, for *Technology Review* and for his class as its secretary.

☐ **Robert C. Cowen,** '49, for *Technology Review*.

☐ **Ward J. Haas,** '43, for the Association as a member of its Board of Directors.

☐ **Warren J. Henderson,** '33, for *Technology Review* and for his class as its secretary.

☐ **James H. Howard,** '25, for his class.

☐ **Gordon W. Moore,** '60, for the M.I.T. Club of Colorado.

☐ **Pamela Reekes McKirdy,** '71, for her class and to the Technology Day Committee for 1980.

☐ **James O. McDonough,** '43, for his class.

☐ **Margaret L. MacVicar,** '65, for the Association through her leadership and sharing of the UROP program.

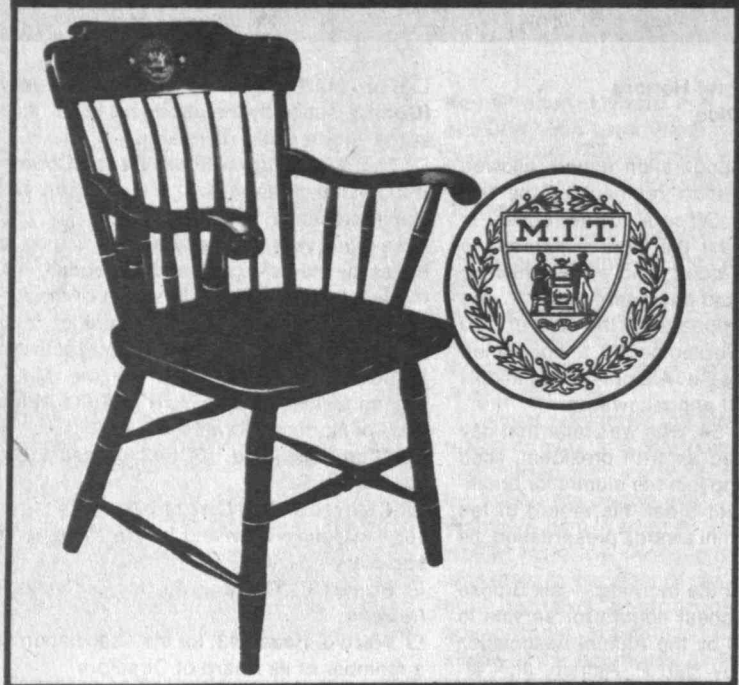
☐ **Donald E. Robinson,** '46, for leadership in the Tampa (Fla.) Bay area.

☐ **C. Haskell Small,** '30, for the M.I.T. Club of Washington, D.C.

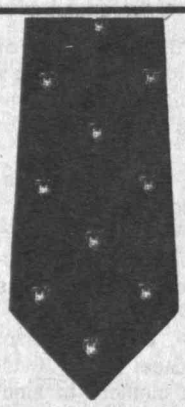
Dr. Aldrich also paid tribute to nine alumni selected for the first George B. Morgan ('20) awards for "distinguished service to the Institute through the M.I.T. Educational Council": **Philip H. Dreissagacker,** '37, **Bernard Edelman,** '53, **Alan L. Maclean,** '44, **Francis O. Merchant,** '33, **Thomas E. Pawel,** '48, **Arthur J. Power,** '42, **Arthur Schwartz,** '47, **David G. Steelman,** '64, and **E. Hibbard Summersgill,** '36.

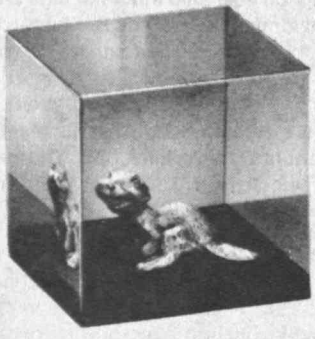
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___	M.I.T. Chair, all black	Express Collect 115.00 ___
___	M.I.T. Chair Cushion	14.00 ___
___	M.I.T. Insignia Tie in navy	8.00 ___
___	M.I.T. Insignia Tie in maroon	8.00 ___
___	Director's Chair () natural	53.00 ___
___	Director's Chair in walnut	59.00 ___
___	Plaque	29.95 ___
___	Engraving () Shield, () Rectangle	7.00 ___
	Name to be Engraved ___	
	Class of ___	
___	Beaver Paperweight	15.00 ___

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		N.E. States	East of Miss.	West of Miss.
Director's Chair	(per order)	2.50	3.50	4.50
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M.I.T. Chair Cushion & Tie	(per order)	1.00	1.25	1.50

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13

GREETINGS — after a month's absence!

I hope you have all had a busy and pleasant summer and are looking forward to the lovely fall weather and the Christmas holidays.

As I don't get much news of '13ers, perhaps I can bore you with some of my activities. I thought when I moved up to Maine that I had really "retired"; but far from it. I have lots of delightful neighbors and we get together frequently for "chit-chat" and social evenings. Phil's daughter, Jan, lives fairly close and we go to the beach for sunning and swimming. I volunteer four hours a week at our local public library, so I am always aware of the new books and wish I had more time to read.

I still have my vegetable garden, which in spite of very little care, grows much more than one person can eat. I have the friendliest, most active small black dog that you can imagine. Her name is "Ebony" and everybody on the Point knows and loves her. In fact, I'm known as "Ebony's mother."

The Inaugural events late in September sound very interesting and I would like to attend, but will not be able to. However, I'm sure we'll hear more about it from those of you who do.

We regret to report the death of **Allan S. Beale** (93) of Sandwich, Mass., on June 26, 1980. He was a former engineer with Fay, Spoffard and Thorndike in Boston and an army air force pilot in World War I. Mr. Beale worked as resident engineer during the construction of the two Cape Cod Canal spans from 1933 to 1935. After leaving the engineering company in 1935, he became clerk of the Wareham Water Department, retiring in 1965.

HAPPY HOLIDAYS. — **Rosalind R. Capen**, Assistent Treasurer and Secretary, Granite Point Rd., Biddeford, Maine 04005

14

A letter from **James B. Reber**, our estate secretary, in late August told of the death of his wife early in July, after two years of failing health. He and Aminda met in Germany in 1956 while Jim was on a round-the-world trip for Columbian Rope Co., of which he was then director. They were married in 1957. They settled in Aminda's hometown, Houston, and kept a summer home in Auburn, N.Y., in a house where, for 56 years, Jim has spent at least part of each year. He is now giving up the home in Houston and is making Auburn his home. His permanent address is now 259 Owasco Road, Auburn, NY 13021. His daughter lives in Johnstown, Penn., and his son lives in Baltimore. Jim has three grandchildren and a great-grandson, who is named after him.

Francis A. Ralton died on June 7, at the age of 89. He was in Course I. In 1916 he was a draftsman and from 1919 to 1946 an engineer with American Woolen Co. in Lawrence and Andover. In 1946 he became a consulting engineer with Conrad & Young, Inc., of East Walpole, and settled in Westwood. During his later years, Frank was an architect's representative (resident engineer) on many construction projects, including Gund Hall at Harvard University. He continued in that work, full-time, until he was 82. Frank had been a member of the Phoenician Masonic Lodge for 67 years and its treasurer for 35 years, and was a member the ASME.

Frank is survived by his wife, the former Hazel E. Patterson; two daughters, Elizabeth Stewart, of Andover, and Rachel E. Richardson, of Newcastle, Maine; a son, William E. Ralton, of North Marshfield; four grandchildren, and three grandchildren, and three great-grandchildren. Frank's family was always very important to him — they read a moving tribute to him at his memorial service. — **Charles H. Chatfield**, Secretary, 177 Steele Rd., West Hartford, CT 06119

16

65th Reunion

By now, you should have received the questionnaire for our 65th Reunion. We really need your input to come up with a format which will offer the location and activities convenient and attractive to those of you who plan to attend. Presently, we are considering staying at either McCormick Hall, M.I.T., or a nearby Cambridge or Boston hotel, from Wednesday, June 3, to Friday, June 5. We'll probably take in the "Pops" on Thursday, June 4, and the luncheon on Technology Day, June 5. The remaining time is available for sharing activities the majority selects. Send us your ideas on what activities we should include and, most of all, let us know if you plan to attend.

Had a nice note from **George Crowell**: "The family joins me in thanking you for your hospitality at Chatham — the clambake was great." **Hy Ullian** writes: "We received the excellent photo of the Reunion. The folks who came all looked well preserved. Freida and I greatly enjoyed seeing again those present and hope that they and others will attend our 65th Reunion." **Ralph Fletcher** continues an active role with his granite operations but manages to slip away periodically for fishing and duck hunting. . . . Recently heard from **Barney Gordon** and he seems to be doing well.

All best wishes and keep writing, keep walking (**Nat Warshaw**) and keep breathing (**Cy Guething**). — **Ralph A Fletcher**, Acting Secretary, Groton Rd., West Chelmsford, MA 01824

17

News from classmates is very scarce this issue I guess the abnormally hot summer was to blame. A note from **Stan Dunning** comments that **Al Lunn**'s health is much improved. He spent the summer with his daughter, Jean, on Cape Cod, and has been able to move about quite freely, even attending a performance at the Hyannis Playhouse. This is surely welcome news.

This is being written in early September, when about a dozen members of the class are looking forward to attending the inauguration of Paul Gray as president of MIT on September 26.

Pat and **Bob Erb** have returned from a delightful summer cruise from Vancouver to Glacier Bay, returning to Seattle and San Francisco. Bob recommends Alaska. Christine and **Walter Beadle** spent the month of August in Southwest Harbor, Maine, returning to Cambridge for Paul Gray's inauguration and the minireunion of Christine's class at Vassar. — **William B. Hunter**, Secretary, 711 Farmington Ave., Apt. B-9, West Hartford, CT 06117

18

During the past few days I have been on the M.I.T. campus several times. Many of you who have not been in these environs for years would be amazed at the changes since our graduation. There is much activity, and quite a number of students in the corridors; no longer can you chat comfortably in these areas. The new Whittaker College building, which will be devoted to health, science and technology, is well along. A building across from the M.I.T. Faculty Club headquarters is being completely recycled for the M.I.T. Energy Department. The old National Research building is being enlarged to take care of the increase in the Sloan School requirements. Further down the West Campus a new dormitory is under construction.

Herb Larner sent me a most interesting letter which described his first assignment after graduation in Cullman, Ala. The project for which he was responsible was to vaccinate people against smallpox — a real threat in 1919. The grandson of Dr. Hartung, who was the medical officer for Cullman, recently came across the details of the program and picked up the story of 60 years ago. He wrote Herb, asking him to visit Cullman again, and this time there was no epidemic.

We are happy to report the golden wedding anniversary of Jean and **Julian Avery** on October 4. Selma and I brought warm greetings from all of you to them in person. Incidentally, my better half and I will celebrate our golden event in November when we will go back to the Inverurie in Bermuda, where we spent our honeymoon.

Len Levine and **Eli Berman** became students this past summer as participants in the Evergreen College at Boston University. Their course continued for five weeks (four days each) with about 40 men and women, all senior citizens, ranging in age from 65 to 89. They were picked up from their houses in Brookline and Brighton by bus at 9 a.m. and returned at about 2 p.m. The lecturers, about 20 professors from B.U., focused on public health problems, investments, philosophy and other



The 1980 Bronze Beaver from Harl P. Aldrich, Jr., '47, president of the Alumni Association, to Harold Bugbee, '20 (left): "Secretary of his class for 55 years, former chairman of the Alumni Fund Board, president of the Association, member of the Corporation as well as a myriad of other alumni offices including the chairmanship of his class' highly successful 60th reunion last June; we salute him for virtually a lifetime of dedicated leadership."

public issues facing all of us. Len and Eli report it was a most rewarding and stimulating experience.

Malcolm Baber writes that they are planning to give up their house in Philadelphia and move into an apartment. The move is scheduled for October 15, and after that their address will be: Hill House, 201 West Evergreen Ave., Philadelphia, PA 19118. Malcolm says, "I hope you have had a fine summer and that other classmates have had more news to communicate."

On a sad note we report the death of **C. Morton Beattie** on June 14 last. A clipping from the *Quincy Patriot Ledger* of June 16 summarizes some of his accomplishments. "He was employed at George's Keith, Brockton, at the time of his retirement and was formerly employed at Estabrook and Co. He was a 50-year member of Rural Masonic Lodge and was a member of St. Stephen's Royal Arch Masonic Lodge."

I am also saddened to report the death of Marie Sackett, who has been George's right hand almost since graduation. It was my good fortune to have known her through the years.

A newspaper clipping from the *Hartford Courant* on June 28 records the death of **Warren Scott** on June 27: "Born in Cambridge, Mass., he had lived many years in West Hartford. He received bachelor of science degrees from M.I.T. and Harvard University. He was a former director of the Sanitary Engineering Division of the Connecticut Department of Health from 1925 to his retirement in 1961. He was a previous sanitation engineer for the Massachusetts Department of Public Health and was assistant professor of public health at Iowa State University.

"He was past president of the Connecticut section of the American Society of Civil Engineers and past president of the Connecticut Public Health Association. He was a member of the Connecticut Water Resources Commission until the time of his retirement, an honorary member of the Connecticut Public Health Association, and a Fellow of the American Society of Civil Engineers."

As these notes are being written, on September 12, the following notice concerning the passing of **John Purves** appears in the *Boston Herald*: "Funeral services were held yesterday in Christ Church, Cambridge, for John C. Purves, 84, a developer and marketer of electronic devices used in the navigation of aircraft on earth and in outer space. He lived on Memorial Drive, Cambridge, and died Sunday in Massachusetts General Hospital.

"He was born in Philadelphia and studied for a year in Germany before entering M.I.T. in 1914. During World War II he served as the head of the enforcement bureau of the U.S. War Production Board from 1942 to 1946. He was chairman of the Cambridge Red Cross Chapter from 1955 to 1963." — **Max Seltzer**, Secretary, 1443 Beacon St., Brookline, MA 02146 and **Leonard I. Levine**, Assistant secretary, 519 Washington St., Brookline, MA 02146

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A dearth of news at this writing. A news clipping reports the death of **Raymond H. Dearden** of Somerset, Mass., on June 2, 1980. Raymond was an architect and engineer. He retired in 1964 as supervising architect in the design department of the U.S. Navy Public Works Center at the naval base in Newport after a service there of 20 years. He is survived by his wife Loretta and his son, Raymond H. Dearden.

Please send me a word or two for these notes which are of much interest to your living classmates. — **W.O. Langille**, Secretary, Box 144, Gladstone, NJ 07934

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Glad to say correspondence has picked up a bit since our reunion. A nice letter from **Irv Wilson** of Lynnfield refers to the excellent picture of him and Ruth at a party to celebrate their 60th wedding anniversary. I am sure lots of you noticed the picture which appeared on page B5 of the August/September issue. Al Breed, who appears in the picture, was class of '21, not '20. Irv's grandson, also in the picture, has been elected to serve on the Corporation. The anniversary celebration may be a worthy excuse for absence at the 60th, but we sure missed Irv and Ruth. Irv gets in several rounds of golf per week and has had enough energy left this summer to split five cords of wood for his stove, thus conserving oil. More power to him!

A note from **Norrie Abbott** answers my request for news of our popular co-ed, **Dorothea Brownell Rathbone**. Sad to report that Dorothea is in poor health and has been in a nursing home in Warwick, R.I., for several years. We can well appreciate how much she would have enjoyed the 60th if she had been able. We missed her.

A friendly letter from **Henry Hills** takes me to task for failing to mention his and Mary's names in the list of those attending the reunion. I told Henry to charge it to senility. At any rate, Henry and Mary were very much present and added greatly to a successful reunion. They sure get around: this summer, Henry and Mary visited Copenhagen, Stockholm, and Oslo, and last year they drove across country and back. Their winter home is in La Jolla, Calif., 7411 Herschel Ave., and they spent the summer in Melrose.

A thoughtful letter comes from the son of **Joshua Muss** from Fair Lawn, N.J. Classmates will remember him as Joshua Musnitsky; he changed his name to Muss some time ago. Joshua was township engineer of North Bergen, N.J., from 1925 to 1966 and continued as a consultant until 1972. He has failed in health and is now in a nursing home. His son read him the 60th class history and believes he appreciated it and would want to thank us for it. His son is also a graduate of M.I.T., class of '53, and is associated with the public works department of North Bergen. The young Mr. Muss comments on a recent trip to M.I.T. and the excellence of its maintenance. He remarks that the changes in Boston had him resorting to maps and that simple two-way streets no longer seem to exist. We can say "amen" to that. Anyone wishing to communicate with his father may write to Miton J. Muss, A-16 Fourth St., Fair Lawn, NJ

Word has been received of the death of **Murray Whitaker** of 320 Florida Ave., New Smyrna Beach, Fla., on May 14, which was the date of his birth. He was a popular and widely known member of the class and his passing is an occasion for deep regret. Our condolences from the Class to his wife, Cora Belle.

Another recent death is that of **Bob Bradley** of South Dartmouth, Mass., on August 25. Bob had been in poor health for some time. He founded and was president of Precision Products Co. of Waltham which supplied parts for instrument panels on airplanes in the U.S. Army Air Corps during World War II. An active and competent yachtsman, Bob was vice commodore and a member of the judging committee of the Boothbay Harbor Yacht Club. He also served as a member of the Maine Yacht Racing Association. He leaves his wife, Ruth, and two daughters. Donations in Bob's memory may be made to the Sloan School of Management, M.I.T. Classmates will remember how lively and active Bob was at school. He was associated with *Technology Review*, played in the Banjo Club, and was coxswain on the varsity crew — a credit to our class. — **Harold Bugbee**, Secretary, 21 Everell Rd., Winchester, MA 01890

21 60th Reunion

After **Laurence Buckner** sent out a belated Christmas letter to various classmates, he received two newsy replies which he thoughtfully sent along to me. **Phil Coffin** commented on the tone of Laurence's letter: "I gather that, like so many survivors of heart attacks, you may well outlive your doctor." And Phil asks about heat pumps in a climate like Florida. "We are stewing about what to do with our big joint in Pittsburgh," he writes, "and are thinking of selling out and renting a place around Chautauqua for the summer months."

Harold Cake wrote, "One of the main reasons I subscribe to *Technology Review* is to keep in touch with old classmates. . . . You in Pennsylvania had your Three Mile Island episode, but we now have had our Mount St. Helens. Right now (July) we are parked in our motor home in a Washington state park 100 miles east of Portland. No evidence of ash here although we are about 50 miles from Yakima which was heavily covered with ash. Crops seem to have come through with modest damage and logging is taking place near the mountain where millions of trees were flattened by the explosion. . . . We drive our motor home to Palm Springs for the winter months but enjoy the Northwest in the summer." Harold reports recent contact with **Bill Matthews** in Spokane and **Ed Chilcott** and **Ted Rose** in Los Angeles, and he has also heard from **Mahlon Hartley** and **Harry Witherow**.

John Sherman sent me an obituary of **John L. Vaupel**, who was with our class in undergraduate days but received his degree is 1922. The 1922 class notes will cover that. **Jack Sherman** wrote, "I retired at the end of 1964 from the Federal Reserve Bank of Boston where I had been an economic statistician for 21 years. Since 1968 I have been employed by the Grand Lodge of Masons in Boston and am now historian for the Grand Lodge."

A birthday greeting from Emma and **Al Lloyd** brought news of their doing. "You may recall that our daughter Barbara and her husband Sam Hayes and their family have been in Switzerland for a year. We visited them for 17 days in their apartment in Lausanne. It's a fascinating country to visit and see how other people live and cope with the problems of our times. Sightseeing is fabulous.

"Last week we had our usual Lloyd family reunion in Westerly — all 16 of us. We took the occasion to celebrate our 50th wedding anniversary (which actually comes in September). Needless to say we had a marvelous time."

An August letter from **Josh Crosby** told of the death of **Allen Addicks** and also sent along a clipping from the *Bangor Daily News* — a letter to the editor from **David Woodbury** urging Maine votes in a September referendum to retain the nuclear power plant at Wiscasset.

Allen D. Addicks of S. Pasadena, Fla., died on July 17, 1980. In earlier years he worked for a publishing company in New York City and later became an independent real estate broker, retiring in 1966.

W. Hoyt Young of Escondido, Calif., died on July 26, 1980. Bill spent most of his career in patent law but took time out to work for the U.S. Navy (Ordinance) in World War II with the rank of Commander. After the war he bought an 88-acre ranch in California where he grew fruit and raised poultry. After 10 years of this, he went back into patent law from which he retired in 1963.

George T. Welch of Poughkeepsie, N.Y., died on August 2, 1980. George received degrees from both Brown University and M.I.T. He was assistant registrar and cost accountant at M.I.T. until 1931, and two years later he went to work as assistant comptroller at Vassar College, where he retired as treasurer in 1963.

The sympathy of the class goes out to the families of these classmates.



The 1980 Bronze Beaver from Harl P. Aldrich, '47, president of the Alumni Association, to Philip K. Bates, '24 (right): "Dedicated alumnus of the Class of 1924, for 50 years he has devotedly served the Institute in a multitude of alumni activities: club president, long-time educational counselor and honorary secretary, several terms on Corporation visiting committees, and for decades the western vice-president of his class — these are but a sampling of the positions he has so ably filled as an effective and positive influence for M.I.T. in Southern California."

A late August letter from **Grant Miner** tells of his receiving a phone call from Helga and **Jim Parsons**. Helga inquired how Grant's writing was coming along? Answer: no writing! The Miners are both having some health problems (oh, to be young again) — Marianne having had a fall in her bedroom and Grant an overnight stay in the hospital after almost suffocating in a supermarket. The diagnosis was an acute allergic attack from a deodorant spray.

A postcard from **Helier Rodriguez** says he and Graciela are in Spain for 30 days but hope to return to attend the inauguration of Paul Gray. — **Sumner Hayward**, Secretary, 224 Richards Rd., Ridgewood, NJ 07450; **Josiah D. Crosby**, Assistant Secretary, 3310 Sheffield Cir., Sarasota, FL 33579; **Samuel E. Lunden**, Assistant Secretary, 606 S. Olive St., No. 701, Los Angeles, CA 90014

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Your secretary is excited these days about the September 26 inauguration of Dr. Paul Gray, our 14th President. We hope to bring you more news for the next notes.

We will see **Randall Spalding** there from the Spalding Inn Club at Whitefield, N.H. Randall is finishing an interesting season at the Inn with special attention being given to bowling-on-the-green and visiting the adjacent colleges for the fall football games. He has issued a friendly invitation to all members of our class. Randall and **Bill Elmer** are both members of the N.H. Society, Sons of the American Revolution. The Spaldings will be vacationing in Sarasota, Fla., and hope to meet with **Parke Appel** and the West Florida group. He says he continues to supervise lawn bowling activities for about five hours every day in a most enjoyable atmosphere. He recalls that **Dale Spoor** was an enthusiast in the sport.

Sumner Hayward, '21, has forwarded clippings from Ridgewood with the obituary of **John L. Vaupel** of Boothbay, Me. John died on July 20, 1980, in an Augusta hospital after a lengthy illness. He was an army veteran, a member of Boothbay Masons, a former school board member, and a member of the planning board. He worked with Phoenix Steel Corp. as an engineer from 1937 to 1963 and remained in Belmont until 1968, allowing him to attend many of our class meetings.

We have also received notices of the 1979 death of **Rodger D. Carver** of Toccoa, Ga., and **Maurice Rogers** of Orange, Ct. Our sympathy goes to their families.

An article in the *Boston Globe* tells of our loss in June 1980 of **Harry R. Kimball** of Brookline — formerly of Salem and Lynn. After working for chemical companies, he founded several plastic firms as well as firms making shoe machinery. He was a student of Hebrew history and wrote several books on Jewish theology. He leaves two daughters, a brother and five grandchildren.

We also report the death of Colonel **Paul C. Howe** of New Port Richey, Fla. A generous donation for the Alumni Fund has been received from his widow, Mrs. Mary C. Howe. Our thanks go to her with our sympathy.

Comprehensive reports will follow our meeting at M.I.T. in September. Good health to you all. — **Whitworth Ferguson**, Secretary, 333 Ellicott St., Buffalo, NY 14203; **Oscar Horovitz**, Assistant secretary, 31 Montrose St., Newton, MA 02158

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Vivian and **Dick Frazier** have been presented with a grandson by Andrew and Nancy Frazier of Mahwah, N.J. Alexander McGinnis Frazier was born on August 11 and was duly inspected by his grandparents ten days later. He is the first boy of four grandchildren.

Royal Sterling has been in Nova Scotia fishing.

Benjamin Lane died on May 22 in Walnut Creek, Calif. Benjamin graduated with our class in mining engineering and metallurgy. He was a district manager for Joy Manufacturing Co. in Chicago and later became manager of export sales and president of the International Executives Association. He had lived in Scarsdale, N.Y., for some time prior to retirement.

Benjamin Robbins died on June 14 in Milton, Mass. He studied mechanical engineering with our class and became an engineer for Jackson and Moreland in Boston. He was a member of the Milton Hoosic Club. — **Richard H. Frazier**, Secretary-Treasurer, 7 Summit Ave., Winchester, MA 01890

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The editor's request for reduced space was automatically incurred by a paucity of news. **Osborne H. Davol** passed away July 12, 1980, in Tiverton R.I. after a lengthy siege of lung cancer. He gained his S.B. in mechanical enginnering and had retired as chief engineer of the Electro Metallurgical Division of Union Carbide, Niagra Falls, N.Y. "Dippy" was best known as the partner of **Dave Grant**, the ivory tickling "Dippy Dave Duo" which "rolled in the aisles" wherever the Musical Club went. His and Kathy's renditions highlighted the 55th at Exeter, N.H.

Stanley Higgins died May 7, 1980, in Arlington Mass. He registered in civil engineering and was a resident engineer for Anderson, Nichols and Co., Inc., of Boston and a civil engineer for the town of Lexington for 20 years. He fought in a number of important battles in France in World War I and was a lifetime member of Disabled American Veterans.

Bransford W, Crenshaw passed away of emphysema in St. Louis April 22, 1980. He received his S.M. in mechanical engineering after graduating from Kansas University in 1923 and was the retired president of Scullin Steel Co., Chicago. During retirement, he was active in the Small Business Administration and helped found the Service Corps of Retired Executives. He was a member of ASME and a number of golf clubs, and he was particularly proud of his M.I.T. association.

Ex-class president **Frank Shaw** is recuperating in the Wellesley Convalescent Home, 878 Worcester St., Wellesley MA 02181, after a heart valve replacement. . . . **Gordon Joyce** is enjoying outdoor walking after a month's hospital treatment for cellulitis. He recently had a pleasant visit with his daughter in England. . . . **Phil Blanchard** and **Don Moore** are anxiously awaiting returns from their mini-reunion poll. . . . Gertrude and **William Lanagan** have just celebrated their 50th wedding anniversary. Bill was city clerk in Waltham for 35 years, retiring in 1970. — **Russell W. Ambach**, Secretary, 216 St. Paul St., Brookline MA 02146; **Herbert R. Stewart**, Co-secretary, 8 Pilgrim Rd., Waban MA 02168

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Welcome letters arrived from two classmates just as these notes were due. **Willard Allphin** writes that he couldn't make our 55th but is aiming for the 60th. A year ago he and his wife flew to Europe and spent some time in Saas Fee, Switzerland, Paris, the Isles of Scilly, and London. For several years they have wintered in Florida, staying in campgrounds for six weeks in their camper and then going to Bonita Beach and staying in an apartment for two months, camping at various spots on the way home. However, this winter they are booked for their fourth freighter trip in January, going to the west coast of South America.

The second letter came from **Hollis Ware**, who was sorry to have missed the 55th but his wife's health prevents traveling. Hollis enclosed the *New York Times* article announcing the passing of **James S. McDonnell, Jr.** on August 22 at his home in Ladue, a suburb of St. Louis. Jim suffered a disabling stroke several weeks before his death. Up to that time, he had remained active as chairman of the McDonnell Douglas Corp. Jim was born in Denver, graduated from Princeton in 1921 and obtained his master's degree in aeronautical engineering from the Institute in 1925. Jim was recognized as an aviation pioneer and his accomplishments over the years were many. In 1939 he founded the McDonnell Aircraft Corp., starting with one employee in a rented office at Lambert Field in St. Louis. In 1967 he was credited with achieving the largest aerospace merger in history with the acquisition of the financially troubled Douglas Aircraft Corp. Although primarily a weapons maker, Jim gave much thought to the prevention of war. In an interview about a year ago, he said that he wanted to be remembered not only as the maker of more than 7,000 war planes but as a "contributor to mankind." Jim is survived by his wife, the former Priscilla Brush Forney, two sons, and three step-children.

Belatedly we learn of the passing of **William R. Dagnall** in Putnam, Conn. on October 30, 1979. — **F. Leroy Foster**, Secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650

26 55th Reunion

In the previous issue of the *Review* we quoted from **Whitney Ashbridge**'s letter listing some of his world-wide accomplishments. Since many of our classmates have had very fasinating experiences it would be our hope that you will be willing to shed your accustomed modesty and tell us about them to pass on through these notes.

Bill Hoar returned recently to Karachi, Pakistan, to live with his daughter, her husband and children after having been evacuated a year ago. On the way he stopped in Switzerland to attend the graduation of his number two granddaughter who then went to Saudi Arabia with her father. As a railroad engineer, Bill has worked in Central America, Bolivia, Vietnam, Laos, Thailand, Saudi Arabia, France, Germany, and Great Britain. Meanwhile, he raised 5 children with 10 grandchildren who seem to have inherited his wanderlust. His present address: c/o Borter, KARACHI, Dept. of State, Washington, DC 20520.

Don Cunningham and his wife travelled to the Greek Isles and Turkey in October, having perviously cruised Egypt, Petra, Suez Canal, Israel, Cyprus and Athens. Earlier this year, they covered Hong Kong, Bangkok, Burma, Java, and Bali. He mentioned a prospective visit to Southport, Maine, which in past years has included a mini-reunion with **Win Russell** and **Dick Sherman** at East Boothbay. An interesting side-note: Don is a descendant of Eliza Sherman through his paternal grandmother. Eliza built the East Boothbay homestead in which Dick Sherman lives. We will shortly join with Don and other committee members to make plans for the 55th Reunion. **Joe Levis** has gladly agreed to resume his former activites with me on the sports and entertainment aspects. **Bob Dawes** and I, with our respective Evelyns, hope to meet shortly with **Ruth Smith** at Pigeon Cove and may be able to secure Smitty's class records and reunion materials.

A letter from **Bill Davidson** reads, in part: "Sorry to be so late in answering your letter but various complications of my condition have kept me rather weak much of the time. I would love to have visitors from the class. Even though Florida does not seem to be popular with the '26ers, a few must pass this way once in a while. While **Chet Buckley** was alive he used to get a group together once in a while." Bill's address: 607 Owl Way, Sarasota FL 33577. Tel. 813-366-4355. A note from **Stewart Perry** indicates he is well and busy with his activities at Station WIBB. His address is 36 Pleasant St., Winthrop MA 02152.

With regret we now turn to classmates who have passed on: **Hillis R. Clark**, March 4, 1980, Waterbury, Conn. and **Richard B. Parsons**, April 4, 1980. Richard had been vice-president and manager of Weymouth Light and Power and president of Quincy Electric Light and Power and Norwood Gas Co. He is survived by his wife Gertrude (Smith); four daughters, Mrs. Louise Piattelli of Florence, Italy, Mrs. Carol Stuart of Chatham, Mass., Mrs. Sarh Sayre of Barrington, R.I., and Mrs. Hope Schmidt of Aalborg, Denmark; and a son, Richard Parsons Jr., of Marathon Key, Fla.

Edmund G. Bromilow, July 26, 1980. He had lived in Newtown, Conn., during a long illness. A letter from his niece tells of his struggle over many years against Parkinson's disease, and his career with General Electric in the Phillipines, Panama, and Indonesia. He is buried in his native Quebec and information on him can be secured by contacting his nephew J. Bromilow, 61 Cote St. Luc Road, Apt 296, Hampstead, Montreal, 254 PQ Canada.

Angelo P. Maschi of 79 Wilson Ave., Framingham, MA 01701. Delayed notice of his death January 9, 1978. **William M. Work**. March 27, 1980, by letter from his lawyers with no further information except address: 1301 Frank St., Galesburg, IL 61401. **Paul Lester Mahoney** of 978 Post Rd., Scarsdale, NY 10583, survived by his wife Marceline and three sons, Barry, Robert and John. We hope the widows will be able to attend our 55th Reunion next June in Chatham, where we would like to express our sympathy and recollections in person. — **William Meehan**, Secretary, 191 Dorset Rd., Waban, MA 02168 (617) 527-2995

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Our reunion chairman **Dike Arnold** has recommended a change in plans for our 55th in June 1982. The Wianno Club where we enjoyed our 50th is available for a post-Technology-Day reunion, and he has reserved the Club for the period, hoping that this will meet with approval. We would leave for the Cape after the Technology Day luncheon and hold our reunion activities thru Sunday noon.

A letter questionnaire is planned to be sent to the Class this fall. Please cooperate by sending in your reply, including a non-binding indication of your plans for attending. Wianno has all the facilities we need and is a great setting for our reunions.

Ray Hibbert, our wealthy class treasurer, has finally retired. He sold his sales representation organization and now takes time to travel to California to see his family. So that leaves **Carl Davies** in Charleston still working in his lumber business. Carl has been selling lumber for 53 years and says he enjoys it so much he can't give it up. Business must be good because he reports that the Kiawah Island resort near him in South Carolina developed by the Arabs sold $10 million worth of real estate in 15 minutes last week. I wonder how many others are still on the nine-to-five routine.

Your secretary is still active as part-time controller for Milton Residences for the Elderly and Winter Valley Residences, as well as working with the Milton Historical Commission documenting old houses. I did get a chance to have several weeks of sailing my *Flying Gull* down the Maine coast this summer.

Regret to have to report two old and one more recent death notices from our Class. **Emory F. Patterson** (architectural engineering) died August 15, 1979, in Green Valley, Ark. He was with the Stran-Steel Division of National Steel in Washington, Ill., and retired in 1965 to live in

Brunswick, Me., until moving to Green Valley in 1975. **Harry E. W. Tinker** died on September 24, 1979, in Miami Beach. He was employed in Los Angeles for many years and retired to Florida in 1967. **Middleton L. Perry Jr.** died on June 28, 1980, in Roeland Park, Kans. He graduated in electrical engineering with both S.B. and S.M. degrees and was a professional engineer employed by Black and Veatch, Consulting Engineers, Kansas City, from 1936 until his retirement in 1973. He was a life member of IEEE, a 32nd-degree Mason and a 50-year member of the Scottish Rite of Freemasonry.

To the three widows and families of these classmates we extend our belated but heartfelt sympathy. — **Joseph C. Burley**, Secretary Pro-tem, 5 Hutchinson St., Milton MA 02187

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This issue of class notes will reach you close to the year's end. May we wish each of you happy holidays and a very good year ahead!

Our most geographically remote yet consistent correspondent is **Shikao Ikehara**, who lives in Tokyo, Japan. Postcards from Asako and Shikao came from the Philippines this year and tell us that they were there to visit their daughter, Reiko (who lives in Manila), and to welcome the arrival of their seventh grandchild. Our congratulations to all!

We have a warm and friendly letter from Lillian (Mrs. **Thorwald**) **Larson**. She is living near her daughter in Ann Arbor, Mich. but hopes to spend the winter in Florida as she and Tom have done regularly in the past. . . . A letter from **Bill Hurst** brought up a point of interest that is seldom mentioned: namely, that there are many intraclass acquaintances and friendships that predate the student years at M.I.T. Bill, Tom Larson, and **Charles J. Hall** were not only classmates during four years at old Mechanic Arts High School in Boston but they were the three top honor recipients at the school's graduation exercises. Following graduation from M.I.T., Tom and Bill remained in touch with the Institute but Charlie dropped out of contact some years ago. Since Bill is anxious to locate Charlie, we would like to hear from anyone who knows anything of our missing classmate.

We had a very pleasant telephone visit with **Phil Taylor**. Phil reports that he and Iris are generally in good health. They divide summer vacations between the Cape Cod seashore and the mountain country at Franconia, N.H. At home they spend a fair amount of time improving the house. Phil expects to see **Charlie Southwck** in late September or October when Charlie returns from a trip to Europe.

Jim Donovan keeps up his valuable service as a reporter for these notes. In late summer, he and Frannie had a good telephone chat with Pam and **Rene Simard** (two telephones at each end). The Simards appeared to be in good health and spirits. . . . During the Labor Day weekend, Jim talked with **Ed Poitras** by telephone. Ed and Pat have sold their big old home in Holliston, Mass. and are enjoying the freedom of less extensive quarters. Ed says he enjoys reading about his classmates in the notes and promises to write about his own activities.

We are pleased to announce that **George Palo** will take on the duties of class agent. George and Anne have long been active in class and Institute affairs. They expect to attend the Alumni Officers' Conference at M.I.T. in September. — **Walter J. Smith**, Secretary, 37 Dix Street, Winchester, MA 01890

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Russ Clark and his wife Dot celebrated their golden wedding anniversary on July 31, 1980. A reception was arranged for them by their children at the Top of the Cliff Club in Dallas, Tex. Russ's professional career has been in aeronautics and astronautics, having worked for LTV and Vought Corp. He was chief engineer for the F84 *Crusader*, which won the Tompson and Collier trophies. He has been vice-president and general manager of LTV Aeronautics and Astronautics Divisions. Currently he is executive consultant to Vought Corp. He is a member of the U.S. Air Force Scientific Advisory Board, NACA Committees. He is a member of the M.I.T. Visiting Committee and the M.I.T. Educational Council. His hobbies include photography and golf. The Clarks spend their vacations in their condominium at Steamboat Springs, Colo.

Rolf A. Zurwelle is still active in products design as a general engineering consultant. "By the grace of Almighty God," he continues, "I am in good health."

A note from **J. Wesley Walters** of St. Paul, Minn. reads, "I am now 75 years old and it is painful to think that another year has gone by." Wes was connected with the U.S. Army Corps of Engineers (St. Paul district) all of his professional life. He was involved in various projects in northern Minnesota and the Dakotas and rehabilitation of the Mississippi River navigation locks. He retired in 1965 but continued working part-time as a consultant. Wes and Jo are great travelers which is one of their main hobbies. They have traveled through all the states and visited almost every capital city. They also have traveled through Europe extensively a number of times.

A note from **Jonathan F. McCray** of Heber Springs, Ark. reads, "Many thanks for the birthday card. It was kind of you to remember, though I'd just as soon forget the years that are piling up. I like to repeat once again how much we enjoyed the 50th Reunion and enjoyed seeing you, **Jim Fahey**, **Jerry Gardner**, and others. It was a real pleasure for me and my wife Isabel. We have another M.I.T. alumnus nearby, Arch Copeland, '38 and his wife Jo Ann. We find Arch and wife delightful companions. I have succeeded in getting both of them to join us as volunteers for Tax-Aide, which provides assistance to the elderly, the minorities, and the poor in filing their income tax papers. During the season, from January to April 15, we help about 60 persons to file their federal, state, and homestead exemptions. We had such a mild winter this past year that we did not bother to travel. We love our house and enjoy living in it, but when the weather gets cold, we begin to think of warmer climates. Our very best wishes and kindest regards to all."

Seymour A Baum of Farmingdale N.Y. writes, "Still here at the same stand and enjoying it to no end. Business is good and only the tax-man is real annoying. My wife Claire and I spent half the year here and the rest of the time in Florida. I manage quite a bit of golf in both places." Seymour is president of B. H. Aircraft Co. of Farmingdale, N.Y.

A note from **Norman M. Wickstrand** of Harwinton, Conn., states, "Many thanks for the birthday greetings which, through your efforts, always come on time, in spite of a slight error in the address — Torrington instead of Harwinton. I have lived at Harwinton for 22 years, although I worked in Torrington before I retired 10 years ago. Shortly I will be 75 years old, but fortunately I am in good health — at least I have no special problems. I believe I am one of the older members of the class, as I did not enter M.I.T. directly from high school. I still enjoy playing chess and I do a little wood carving and some sketching. Yesterday, I went to Rockport, Mass., to try my luck at sketching. We are not great travelers. I greatly enjoy the math problems in the *Review* and almost every month I struggle through at least one of them." Professionally, Norman is an analytical engineer and draftsman, having worked for New Departure for 20 years and the Torrington Co. for 16 years. He is part-time lecturer at the University of Connecticut and has had two ASME papers published, one of which was translated into Japanese. He has done analytical and statistical work on ball, roller, and needle bearings for 21 years. His other hobbies are nature walks and mountain climbing (including membership in the Appalachian Mountain Club since 1934). He is active in other conservation and environmental efforts. They have attended a number of five-year reunions, including the 50th.

A note from **John Happel** of Hastings-on-Hudson, N.Y. states that he went to the 7th Congress on Catalysis in Tokyo in early July and then hiked near Lake Placid. "Our youngest daughter was admitted to Harvard for graduate study in anthropology and I suppose we will be visiting her and see more of Boston." For most of his career, John has been a professor of chemical engineering at New York University. He also is president of Catalysis Research Corp. in New Jersey. He was a chemical engineer for Mobil Oil Co., jointly responsible for design and initial operation of the world's largest butadiene plant for synthetic rubber; chairman of the Department of Chemical Engineering at New York University, where he published over 100 technical papers and authored books on chemical process economics, hydrodynamics, and catalysis. John's latest article entitled "Nature, Man, and Energy" was published in the *Forum*, subtitled "Columbia chemist meets the greatest challenge to contemporary society: the energy crisis." Presently, John is adjunct professor and senior research associate at Columbia University, and vice-president of the New York Academy of Sciences. His hobbies include hiking, sports, gardening, and travel. He and his wife have taken trips to Europe, Japan, Russia, and the Caribbean in recent years. He is a member of the Chemist's Club, Alpha Chi Sigma, Tau Beta Pi, and the ACS. — **Karnig S. Dinjian**, Secretary, P.O. Box 83, Arlington, MA 02174

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Some of the information forms I send out periodically have been returned, and the following news comes from them. After graduating with our class in 1930, **Howard Robinson** remained at the Institute until 1935 to obtain a Ph.D. in physics and then went to work for Armstrong Cork Co. in Lancaster, Pa. In due course he became chief physicist and manager of physical research. During the years 1949 to 1957 he shifted to the diplomatic service, first as an attache at the American Embassy in Stockholm and later as first secretary of the Embassy and Special Assistant to the Ambassador at the American Embassy in Paris. After this diplomatic interlude, Howard moved in 1958 to the physics department of Adelphi University at Garden City, New York. At the time of his retirement in 1976, he was departmental chairman. During his years at Adelphi, Howard acted as translation editor for the Journal of the Optical Society of America, responsible for articles appearing in the Soviet Journal of Optical Technology.

The Robinsons, who now live in Gloucester, Mass., have three children: Marina who is married and has two children; Peter who is chairman of the Department of French at the University of Minnesota and has four children; and Holbrook who is chairman of the Department of Languages at Northeastern. Howard reports that he has recently seen **Bill Perret**, who is retired and living in Albuquerque, NM.

As previously reported in the class notes, after retiring from the U.S. Geological Survey in 1974, **Dave Landen** became an assistant professorial lecturer and later an associate professorial lecturer at the College of General Studies of George Washington University. He has long been active in the Washington, D.C., Society of Engineers, of which he was recently made a life member. His other memberships include the Torch Club of Washington, American Society of Cartography (honorary member), American Congress of Surveying and Mapping (life member), and the M.I.T. Club of Washington. The Landens have two children: Deborah who holds an M.D. degree from Wayne State University and James who is a second-year student at the Medical College of Virginia in Richmond.

Supplementing last month's note about his nomination as a life member of the M.I.T. Club of Fairfield County, Conn., **Tony Savina** has been participating as a coordinator in a unique type of educational program at the University of Connecticut at Stamford. The Savinas are members of the organizing committee of an "Institute for Retired People" in which retirees meet in small seminar groups to pursue a subject on a self-motivated, self-directed basis. The retirees plan their own program and act as both faculty and student body. Tony is also president of his local AARP chapter. The Savinas have two daughters, both of whom received magna cum laude degrees and are members of Phi Beta Kappa. Mary holds a B.A. from Carleton College, Northfield, Minn., M.S. in geology from U.C. at Berkeley, and is teaching geology at Carleton College. Jean received a B.A. from Gettysburg College, a master's degree in occupational therapy from the Medical College of Virginia in Richmond, and is now employed as an occupational therapist at a hospital for children in Elizabethtown, Pa.

Tony reports that he saw **Lester Steffens** shortly before the 50th Reunion and unsuccessfully tried to persuade him to attend. Les is a member of a dramatic group in Darien that performs Gilbert and Sullivan operas. . . . **Haskell Small**'s manifold business and non-business activities in Washington, D.C., and his memberships and directorships in artistic, child welfare, religious, and business organizations in the District have been previously reported in numerous issues of the Notes. In addition to these previously reported memberships, he is now chairman of the Site Committee to select a location for the USO-Bob Hope Building. Haskell's son is a concert pianist who performed in the M.I.T. Library Series about three years ago.

Win Hartford has retired from his teaching position at Belmont Abbey College in Charlotte, N.C., with the rank of Emeritus Professor of Environmental Science. He has recently accepted an invitation from the Industrial Division of the Royal Society of Chemistry to present a paper on the industrial chemistry of chromium at a symposium at the University of Salford, near Manchester, England. — **Gordon K. Lister**, Secretary, 294B Heritage Village, Southbury, CT 06488

31 50th Reunion

We have more information about our 50th Reunion. We will gather at the Harbor View Hotel on Martha's Vineyard on Sunday, May 31, and return to Cambridge on Wednesday, June 3. Housing can be obtained on campus at $7.50 per person per night, or if you prefer hotel rooms, that can be arranged. A dinner is planned for Wednesday evening and Thursday there will be a reception at the President's House followed by a buffet dinner for our class and Pops. Friday, June 5, will be Technology Day, and you will have a chance to see interesting changes on the campus before the Alumni Luncheon where our 50 Year Class Gift will be presented. If any of you haven't received the information about our upcoming 50th Reunion, please drop me a line.

A most welcome note from **Lou Evans** reads: "While I was in Mykonos in 1979 I met Jim Wei, Sc.D. '54, now head of the Chemical Engineering Department at M.I.T. Jim, whom I had known when we both worked for Mobil several years ago, happened to stop at Mykonos while on a yacht cruise of the Greek Islands. He was interested in a story I wrote while in Indonesia, describing the Arun LNG Project in an Alice-in-Wonderland style of writing. He suggested that if I condensed it to a suitable length, he would like to have it published in *CHEMTECH*, so I'm working on that. I just returned from my annual two-month vacation in Mykonos, and am fully recharged for more action on Mobil's Middle East training projects. And, of course, I brought back a few more exotic sea urchin skeletons to add to my collection."

The Mobil newsletter which Lou attached to his note is too long to be included in these notes, but if any of you would care for a copy, drop me a line. The article includes a summary of Lou's career. After graduation he spent several years with Texaco, then joined Mobil at the Paulsboro lab. During his nearly four decades with Mobil, he built an enviable record in research and manufacturing. He designed and operated pilot plants to test refining ideas; supervised groups of engineers, scientists and laboratory technicians; contributed ideas resulting in more than 50 patents for lube and fuel refining processes; helped to develop Mobil's thermofor catalytic cracking process. For the last ten years of his career, he was manager of technical training for MRDC at Paulsboro.

Helen and I recently spent some time in Washington, D.C., visiting many of Helen's friends there, after which we took off for Ireland. Although we had a most enjoyable time, it was good to get back.

A note from his brother Russell tells of **Elmer C. Hughes**'s death on June 27, 1980. Elmer was an industrial engineer and management consultant and taught at Cornell University, Syracuse University, and Le Moyne College. . . . Another note from John Moriaty, '30, advised of **Nelson B. Haskell**'s death on August 5, 1980. Before retiring, Nelson was manager of Administrative services at Texaco. Our sincere condoleence to their families. — **Edwin S. Worden**, Secretary, P.O. Box 1241, Mt. Dora, FL 32757; **Ben W. Steverman**, Assistant Secretary, 3 Pawtucket Rd., Plymouth, MA 02360; **John R. Swanton**, Assistant Secretary, 27 George St., Newton, MA 12058

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From conversations with **Arthur Marshall**, I can report that he is very busy as a labor lawyer. He travels a great deal and is in the process of transferring much control of his practice to his son.

We have received the sad news that **Harold A. Traver** died of cancer on July 1, 1980. He was a specialist in patent and trademark law. He joined Pennie and Edmonds in 1933 and retired in 1977. During the war he worked for the Office of Scientific Research under Vannevar Bush. Harold's friend, Robert Franklin. writes to tell us how Harold was a student leader of the Glee Club and a fine pianist. Harold is survived by his wife Barbara, two sons, a daughter, and one grandchild. An endowment fund in his memory has been started at M.I.T.

We have also received word that **Elwood Schafer** died. When we receive more obituary information we will pass it on.

Our class golf tournament did not receive much response. We'll forget about it for now. — **Melvin Castleman**, Secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

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There's no question this time who rates the banner headline: the one and only **Ralph E. Cross**, who has established the Ralph E. Cross Lectureship in Manufacturing Sciences. Ralph is chairman of the Cross-Trecker Co. Each year a leading figure in the manufacturing field will be invited to give a series of workshops at M.I.T., focusing on the pivotal issues in the development of manufacturing sciences. Professor Nam B. Suh of the Department of Mechanical Engineering presented Ralph with a plaque commemorating the establishment of the lectureship, on behalf of the laboratory where the lectures will be given. The lab seeks to establish a rational foundation for productivity increases through innovative methods and devices, a systematic understanding of the complex interactions among the many facets of manufacturing, and an important talent base for bright young people in production. Ralph, you are providing an enormous step in our productivity balance where previously about all we have asked is that productivity increases precede wage increases. You have our thanks for a most unique gift to our national well being.

A fine note from **Neil Hopkins** reports that they did go to their son's wedding in California. Their daughter and her husband also attended the wedding, as well as their grandson and his fiance. The six-day trip was not too easy with Ruthie's wheel chair and its attendant problems. Since the trip Ruth had a bad fall, broke a femur, and is still hospitalized. Hop provided a bit of nostalgia by mentioning the 1933 senior prom, where a married couple named Henderson attended with three bachelors in tow — Hopkins, Bill Harper, and John Howell. Thanks, Hop, and best to Ruthie.

We have a long and good letter from **Bill Harper** with plenty of philosophical comments and advice on personal matters. He says that all he reads in the *Review* is class news, which is a mistake. It's not only an alumni magazine, but also M.I.T.'s national magazine. Friends of mine in the publishing business allow that our *Review* is tops in its field.

Otto Putnam comes through with a fine letter mostly about the 5th Reunion crap game. Otto saw **Bob Hentschel** in Wilmington recently where he is retired from DuPont. Bob works at making masterful antique furniture reproductions. He says, "I have a daughter and a son with master's degrees from Harvard." Otto says that he designed a Dyestuff plant in Belgium in 1969, then retired.

Someone in the old Course XVI asked me to help locate **Ed Rowell**. Having heard that he went to Maine, I placed an ad in several Maine papers. Nary a reply. Now comes a letter to **Beau Whitton** written by said Rowell, living in Wellsboro, Pa. Ed has been retired for five years but is carrying on a consulting business part time. A portion of the part time is a quarry deal with a contractor who has the job of supplying 90,000 cubic yards of stone rip-rap for a dam being built by the Army Corps of Engineers. That's it for Ed until he writes me. And, thanks to Beau for sending me Ed's letter.

We have a very fine aerial photo postcard from Charalee and **Dick Fossett** who are hiking in Switzerland in and near a town called Sass Fee. The photo shows the lift chair close up, with the town way down in the valley. Thanks, folks. . . . Jean and **Cal Mohr** came through with more about the 5th Reunion, including many names of participants. Gee, I knew them all, but I would not now. So, men, let us forget the search for the pan photo, and I will blow up my 35mm or 16mm movie. . . . With a good letter of condolence from Anne and **Fred Murphy**, we find that the Murphys and the **George Stolls** are contemplating taking an M.I.T. Quarter Century short trip to Switzerland in October. Anne, I can't locate Sheila White — sorry.

We have notes of condolence from several good friends: the Fossets, George and Jane Stoll, Cy Hapgood, Ellis and Roz Littmann, and George and Lucy Henning. . . . Two of our classmates passed on quite recently: **John Danielson**, Course IV, architecture, and **David E. Lee**, Course XV, in June 1980. John is survived by his wife Margaret and a son and daughter. David is survived by his widow, Margaret. We will be writing to these two widows very soon to send the respects of our class.

That covers our story for this issue which includes Christmas, so we offer our best wishes for the holiday season. Yours most sincerely — **Warren J. Henderson**, Secretary, Fort Rock Farm, Drawer H, Exeter, NH 03833

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Items are scarce this month but at least I do not have to report any deaths.

Do you know what paleobotany is? — and that we have an expert in the class? It is the study of fossil plants and our expert is **Henry "Hank"**

Andrews! As professor emeritus, he has had ample opportunity to continue his interest in this field and put the results into a book just published by the Cornell University Press *The Fossil Hunters/In Search of Ancient Plants*. This is by no means Henry's first book, and it is not written as a textbook. Rather, it is a history of the growth of paleobotany and the humanistic side of those who have searched rock formations for signs of fossils. He has done a good deal of this himself in many parts of the world, but his favorite area is the Gaspe Bay in New Brunswick.

Henry lives in Sanbornton, N.H., and, like many of the people written about, he has multiple interests. He is presently working on the restoration of a 50-year-old Laker, which resembles a whaling boat. It has a four-cylinder engine and he has been recaulking the entire hull.

Henry's other recent claim to fame is having been named to the National Academy of Sciences. — **Robert M. Franklin**, Secretary, 620 Satucket Rd. (P.O.Box 1147) Brewster, MA 02631; **George Bull**, Assistant secretrary, 4601 N. Park Ave, Apt 711, Chevy Chase, MD 20015

36 45th Reunion

If all has gone according to schedule by the time you read these notes, the first mailing announcing our 45th Reunion should have reached most of you. I hope you are making plans to attend. It sounds like a delightful place and we can all make the most of our brief sojourn in Cambridge. . . . It is with great regret that I have to report the death of **Alfred Dasburg** in Santa Fe, N.M. on June 3 last. Ann Dasburg sent a memorial contribution to the Alumni Fund. I have written to thank her and asked for more information. The Dasburgs have lived in Santa Fe for some years and previously lived in Rochester, N.Y. where Al was with the General Railway Signal Co.

On June 9, **Robert Hermann** who spent some time with out class died in Hampton Falls, N.H. where he had lived since 1967. He has most recently been affiliated with the Nashua Corp. and the Denison Manufacturing Co. as a consulting engineer. Earlier he was associated with Anderson Nichols and lived in Brookline, Mass. During the forties he was a successful professional wrestler. He was a pioneer member of the Antique Clock Club of America. Hermann is survived by his wife Jean, a sister, and three brothers — **Alice H. Kimball**, Secretary, P.O. Box 31, West Hartland, CT 06091

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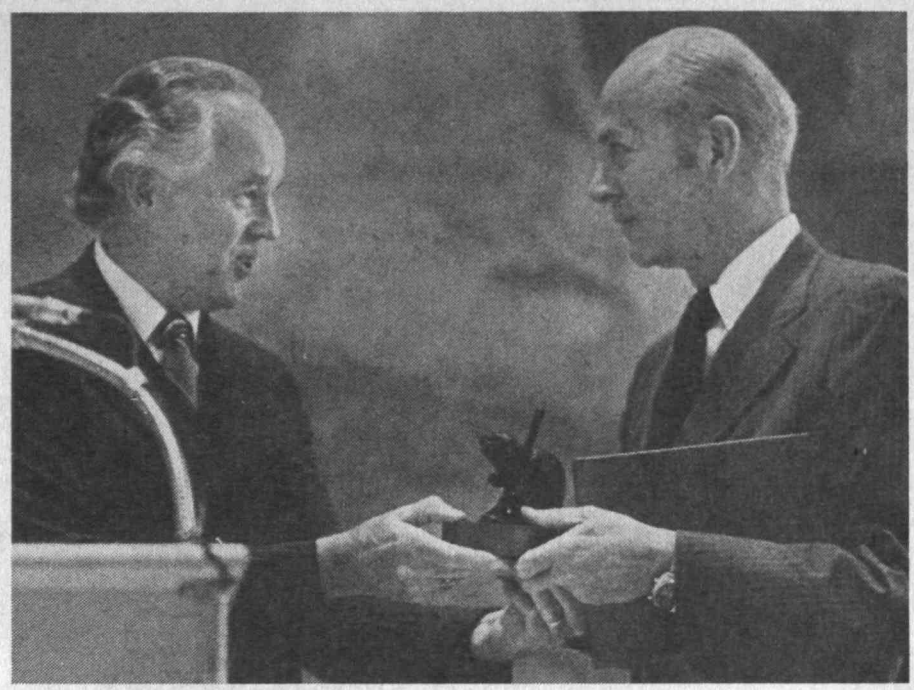
Mrs. **Nancy Klock**, 63 Henry St., Manchester, CT 06040, was recently granted emeritus status as associate professor of electrical engineering at the Engineering School, University of Hartford, West Hartford, Conn. Nancy also funded $2,000 in four $500 scholarship awards in honor of her late grandson, Stanley W. Klock, Jr. Nancy joined the University faculty in 1963. **Fred D. Kierstead** of 312 N. Moon Ave., Brandon, FL 33511, is retired and says he is too busy to make retirement plans. He is a member of the A.R.S. Club. His wife's main interests are home, family, and the Phillies baseball team. His son Fred, Jr., is assistant professor of education at the University of Houston, Texas. Fred Sr. is interested in amateur radio, photography, and is independently involved in research and development in the electrical and electronics field. **Lester Klashman**, Assistant secretary, 198 Maple St., Malden, MA 02148; **Robert H. Thorson** Secretary, 506 Riverside Ave., Medford, MA 02155

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Frank Knight is now living in Norridgewock, Maine, where he is president of Madison Paper Corp. Madison was acquired by Myllykoski Corp. of Finland, and Frank is in the middle of a program to expand the mill from 40,000 tons of paper a year to 200,000 tons. Frank is also a director of Merchants National Bank of Bangor.

Lew Allen, who is chief engineer of Pan American World Airways, was recently named to the additional post of vice-president.

'Tis almost the season to be jolly. In lieu of sending each of you Christmas cards, Sandy and I join with our neighbors Nancy and **Dave Wadleigh**, in wishing you Season's Greetings from the sovereign state of Cape Cod. — **Armand L. Bruneau, Jr.**, Secretary, 663 Riverview Dr., Chatham, MA 02633



The 1980 Bronze Beaver from Harl P. Aldrich, Jr., president of the Alumni Association, to J. Robert Ferguson, Jr., '37 (right): "His quarter-century commitment to the Institute has ranged from club and club advisory board to the Alumni Association's Long-Range Planning Committee, from Educational Council to Corporation Visiting Committee — and a plethora of fund-raising activities including valuable responsibilities during the recent Leadership Campaign. He has enriched each activity by his enthusiasm and his wisdom."

40

Your newly elected secretary really struck out on his first trip to bat. . . . Thanks to **Bruce Duffett** and **Gary Wright**, who called my attention to the error: **Norm Klivans** is our newly-elected president, not **Russ Haden**. My sincerest apologies to Norm, and to Russ, who has already done his stint as president. Guess that Cape weekend was more like a "lost weekend."

It is my sad duty to report the deaths of two classmates, **Theodore A. Edwards**, who passed away in March, and **Jeanne Pearlson Henry**, in July.

Ted, sales engineer for Eimco Mining Machine Division of Envirotech, had resided in Hingham, Mass., for many years. He obtained his bachelor's degree in mining engineering and was a member of A.I.M.M.E., and he served in the U.S. Navy during World War II. Jeanne obtained her bachelor's degree in mathematics and later her Ph.D. in economics from Radcliffe. Her career included serving on the faculties at Penn State, Hofstra, American University, Trinity College, San Jose State, and finally—as chairman of the Department of Business Economics and Finance, at the University of the District of Columbia.

Late last winter Diana and **Sam Goldblith** (he is vice president, resource development at the Institute) revisited the site of the Rokuroshi P.O.W. camp in Japan, from which Sam was released at the end of World War II. Sam had survived the Bataan death march and several years in various Japanese prisons. They found that 35 years of peace have brought many changes, and little remained of the camp except the kitchen, which now serves as a cow shed for a local farmer. In his account of the visit, Sam recalls that after the atomic bomb was dropped, the prisoners became aware that something very important was happening. Two of the enlisted men broke out of camp and stole the only radio in town from the mayor's house, returning to camp with it. Thus they were able to keep abreast of the news, but the villagers were not. On his return trip, Sam gave the present mayor a new am/fm radio as a gesture of friendship. He has recently been made a director of Ionics, Inc., Watertown, Mass., and High Voltage Engineering Corp., Burlington, Mass.

We have learned that **David M. Heskett** has resigned as chief executive officer but will continue as chaiman of Montana-Dakota Utilities Co., Bismark, N.D. . . . **W. H. Krome George**, chairman and chief executive officer of Aluminum Co. of America, was recently elected a director of the company. . . . **John B. Simpson** has retired as executive vice president of energy distribution and general services and as a director of Consumers Power Co., Jackson, Mich. He will continue as president and director of Northern Michigan Exploration Co., a subsidiary.

E. Taylor Lyon writes that he retired recently from the New Jersey Department of Transportation after 18 years of lots of driving. Also that



Diana and Sam Goldblith, '40, photographed at the site of the Rokuroshi P.O.W. camp, Japan, where Sam spent much of World War II after falling into Japanese hands during the Bataan death march.

Philip S. Wheelock, president of the Northern Textile Association, Boston, Mass., was elected to serve on the executive committee.

Norman L. Laschever, who has been active in both the Boston Section of IEEE and on committees for Electro, the IEEE's annual exposition, has been nominated to be secretary-treasurer of the IEEE Boston Section, and a member of its committee; he is currently editor of the *Reflector*. Norman has been with RCA in Burlington, Mass., since 1962 and presently is principal scientist on the staff of the vice president and general manager. . . . **Phil Stoddard**, vice president for operations at M.I.T., was honored at a reception held June 13 on the occasion of his retirement after 33 years of service. We all wish him well in his retirement in New Hampshire.

Cliff Cracauer writes that he decided to come out of hiding and take on the challenge of getting a minority-owned business started on Turtle Mountain Indian Reservation, S.D. So now he is general manager of the Turtle Mountain Manufacturing Co., as well as keeping his consulting business going. — **Don Erb**, Secretary, 10 Sherbrooke Dr., Dover, MA 02030

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Congratulations to **Bill Tallman**, president of Public Service Co. of New Hampshire in Manchester who is now chairman and chief executive officer of the utility company.

Two obituaries this month. **Anthony Sperduto**, who spent a 40 year career at M.I.T. as a member of the nuclear physics research staff, passed away in August after a long illness. **Ernest Kenyon**, who received his bachelor's degree with our class and a Ph.D. in 1944, passed away during the early summer. Ernest worked as a food chemist at the Navy Quartermaster Center for 25 years. We extend our very sincere sympathies to their wives and families. — **Ken Rosett**, Secretary, 191 Albermarle Rd., White Plains, NY 10605

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After performing an excellent job as class secretary for the Class of '43, virtually since graduation, **Dick Feingold** has finally put down his pen and retired from the job. We will miss the way that he kept us all in touch with our classmates even though many of us didn't do a very good job of keeping him informed. The press of his job and an expected relocation has brought about this resignation. We will miss your consistent dedication to the job, Dick, but look forward to seeing you at future class meetings.

Stan Proctor and his reunion gift committee have had about half a dozen meetings to set up the program leading to the achievement of the $1,500,000 objective by June 1983. The results to date indicate that we are already more than half way there. You will be hearing more about the status of the gift from Stan in the near future. It is a great pleasure to work with an individual who is so dedicated to M.I.T. and all it stands for.

It was a real shock to receive a clipping from a Hartford paper which said that **Ed Mikol** had passed away on June 25, 1980 of leukemia in a hospital in Madison, Wis. He was a member of the faculty of the University of Wisconsin where he taught thermodynamics since 1957. In recent years he devoted much of his time researching engineering education and in 1978-79 was the vice-president of the American Society for Engineering Education. Ed was a very active supporter of our class and attended every class reunion. He was pushing very hard for an interim reunion between the 35th and 40th. It is with great regret that we were not able to meet his wish last spring. We will miss this wonderful guy at the 40th but I know that he will be with us in spirit.

Walter Netsch, architect and city planner, received an honorary doctor of fine arts degree from Northwestern at the annual commencement ceremony in Evanston, Ill. He is an eminent architect and planner of large scale and diverse projects for model cities, medical research facilities, industrial complexes, transportation systems, public and private housing, art museums and college and university campuses. His projects include the Air Force Academy, the University of Illinois Circle Campus and the Model Cities Plan for Newark. N.J. In presenting the degree, Northwestern University President Robert H.Strotz called Netsch a master thinker and planner who has brilliantly shown how to use land and space far better than before. His buildings grace our campus from one end to the other, and, on a rather larger scale, the globe.

In a series of management changes at the Celanese Corp., a big chemical, fibers and plastics producer, **Robert L. Mitchell** was named as vice-chairman. Prior to this change, Bob had been an executive vice-president. **George Bartlett**, president of Neway division of Lear Siegler, Inc., is among the five new directors elected by the shareholders of the First American Bank Corp. **Leo Feuer**, president of the William Carter Co., has been elected second vice-chairman of the American Apparel Manufacturers Association.

Al Babcock sends a note that his wife Dee Dee, of 35 years, died in June 1979, and he remarried Barbara Wold in June 1980.

Some bad news, some good news. **Bob Hewes** had a massive heart attach in July and had an extended stay in the hospital. The good news is that he is now recuperating at home. He would very much like to hear from his classmates as he is now retired and will have more time to be a good correspondent (P.O. Box 482, Storrs, CT 06268). — **Kenneth L. Warden, Jr.**, President, 10 Constitution Rd., Lexington, MA 02173

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As I write these notes at the beginning of one new year (just after Labor Day) I realize that you will probably be reading them as we approach the

start of another new year (1981). Since the first is based primarily on the growing season and the second on the sun, it seems doubtful that the two will ever merge into one. And there are those who feel a strong need for the second, if only to take stock of their lives and make an attempt to inaugurate changes.

Jacquelyn M. Findlay, who has been working for the Alumni Association for the past 14 years, was recently appointed to the newly created position of assistant director of corporate relations at M.I.T. Listed among many of Jackie's accomplishments, talents, and interests was the notation that she had catalogued the personal papers of Charles Stark Draper, '26, for the Library of Congress. I'm sure this item of note will activate memories of those who ever came in contact with Dr. Draper or worked in the Draper Labs (formerly the Instrumentation Labs).

Last June the new chairman and chief executive officer of Bethlehem Steel Corp. announced, under a reorganization of top management, that **C. William Ritterhoff**, formerly vice chariman, was to be one of two executive vice presidents.

Henry M. Paynter, professor of mechanical engineering at M.I.T., called me recently to report his latest award: top prize in automatic controls from the American Society of Mechanical Engineers. He said his attempt to dress for the occasion, in contrast to his usual M.I.T. attire, failed when he was unable to rent black shoes to go with his morning coat; he hoped his audience did not see his brown shoes. Hank also spoke of recently seeing and talking with **John Hull** and **Angelo (Butch) Raphael Buccini**. This led to our reminiscing about working together as cheerleaders for a freshman rally in 10-250 preceeding Field Day in 1941.

Marguerite and **Ed Ahlberg**, Priscilla and **Bob Breck**, Anita and **Les Brindis**, **Andy Corry**, Jane and **Lou Demarkles**, **R. J. Horn**, Edna and **Stan Warshaw**, Doris Woodworth (Chet was on a trip), and your secretary spent a wonderful evening — a rained-out swim party — at the new home of Ruth and **Norm Sebell** in North Easton. After dinner we discussed the plans for a Mexican trip sent to us by **Arturo Morales**. It was agreed by us that the committee including Arturo, **Joe Aguilo**, and **Larry Lamadrid** would plan class activities for the free time allocated by the M.I.T. Club of Mexico during the next Fiesta in Mexico, scheduled for March 13-18, 1981. If you have received mailings on this event and want to attend, write to me at once so I can arrange to have you receive the material. You will learn of class activities after arrival in Mexico. I'm looking forward to seeing you at this mini-reunion of the Class of '44. — **Melissa Teixiera**, Secretary, 92 Webster Park, West Newton, MA 02165

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Joseph Mallen, '48

Joseph Mallen, who has been vice-president of operations at Boeing Vertol since June 1979, has been named president of Boeing Vertol He joined Vertol after receiving his master's degree in aeronautical engineering in 1949. His experience at Vertol includes: program manager for the commercial model 234 Chinook; director of engineer-



The 1980 Bronze Beaver from Harl P. Aldrich, Jr., '47, President of the Alumni Association, to Samuel A. Goldblith, '40 (left): "An energetic participant in M.I.T. for more than three decades, this internationally acclaimed scientist has worked unselfishly to strengthen the ties of alumni with the Institute while performing major research, teaching, and administrative roles. We salute him as a friend and advisor who has always maintained a solid commitment to M.I.T.'s highest ideals. The Institute is a better place because of Sam."



The 1980 Bronze Beaver from Harl P. Aldrich, Jr., '47, President of the Alumni Association, to Robert L. Rorschach, '43 (right): "Devoted alumnus of M.I.T., Bob's record of service exemplifies the finest tradition of Bronze Beaver winners. At every level in activities for the Educational Council, the Alumni Fund, as a regional gift solicitor, as a member of the Board of Directors, and in class and club activities, his enthusiasm and caring loyalty have had a remarkable impact on citizens of Oklahoma and on alumni, parents, students, and staff at M.I.T."



The 1980 Bronze Beaver from Harl P. Aldrich, Jr., '47, president of the Alumni Association, to Yaichi Ayukawa, '52 (left): "Loyal son of M.I.T., influential in rebuilding the Institute's relations in Japan. The establishment of the Industrial Liaison Program in Japan and M.I.T.'s close association with his country's alumni, government, and other major industrial leaders are in large measure a tribute to his forceful advocacy on behalf of the Institute. Not only is he the first citizen of Japan to be a member of the Corporation and the Corporation Development Committee, but he is recognized here and in Asia as 'Mr. M.I.T. of Japan.'"

ing for the heavy lift helicopter; chief project engineer for the CH-47 series; and chief of aerodynamics. Joe is a member of the American Helicopter Society, American Institute of Aeronautics and Astronautics, and the Army Aviation Association of America. He and his wife, Emily, live in Media, Pa.; their daughter, Donna, is married.

Bernie Gordon and his wife Sophia donated funds to the Addison Gilbert Hospital to buy an electronic sonic scanner which helps diagnose patients without using x-rays. The data handling portion of the scanner is one of the many electronic devices designed and manufactured at Analogic Corp. which has its headquarters in Wakefield, Mass. Analogic, with two plants and 1500 employees, was established by Bernie 11 years ago; he is chief executive officer. Bernie teaches at M.I.T. and Texas Technological University in addition to his work at Analogic, and has received the Outstanding Living Engineer Award.

Bernie also funded the Bernard Marshall Gordon Professorship of Engineering Innovation and Practice at M.I.T. The professorship, spawned by the Gordon Faculty Fund at M.I.T., was designed to encourage closer relationships with universities and industry. Its aim is to stress proficiency, creativity and product development in engineering.

Alfred J. Murrer was named chairman and remains chief executive officer of the Gleason Works in Rochester, N.Y. Gleason is a diversified maker of machine tools and other products. — **Marty Billett**, Secretary, 16 Greenwood Ave., Barrington,RI 02806

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We had a very pleasant visit in late August when **Dave Moore**, wife Marge, two sons, one daughter-in-law, and one grandson, vacationed their way through the United States and stopped in Madison for a visit. Dave pleaded for a little consideration for you classmates and urged no more poetry in this column.

Thriftiness and nostalgia have given the Fitzpatricks of Holyoke a family tradition. The cap and gown worn by **Henry Fitzpatrick** in 1949 were earlier worn by his uncle and his father when they graduated from Boston College, and then by his brother at Exeter, Harvard, and Harvard Law. Now, Henry's children and nieces and nephews are about to be the third generation wearing the 70-year-old-costume.

We have just received an update on the status of the "Class of 1949 Visiting Professorship." Started as our 25th Reunion gift to M.I.T., each year's undesignated Alumni Fund contributions continue to increase the worth of this fund. The professorship was established to attract outstanding scholars to the Tech. The professorship is generally awarded for a two year term.

Our first visiting professor was Robert Swaim Morison, a nationally recognized biologist and life scientist. Appointed just after our 25th, Dr. Morison served from 1975 to 1977, and provided special emphasis on the study of ethical issues in the medical and life sciences and the future of the health professions. He has remained at M.I.T. and is now in the School of Humanities and Social Science. Gerald Holton is our second and current holder of the professorship. First appointed in 1977, he recently accepted re-appointment. His research interests include the physics of matter at high pressure, molecular physics, and the history of 20th century science. He has been widely lauded for the innovative course in "Science for the Non-Scientists" he developed at Harvard.

These two holders of our professorship are what we envisioned when we conceived the program: bring the best to Tech, so that M.I.T. will continue as the leader and innovator in the sciences. We have just over $400,000 in our fund.

Your contributions to the Alumni Fund will increase the amount available as the years go by. If you feel the ideals and results of our Visiting Professorship are desirable, please help keep it growing. To each of you, may the holidays be happy ones, and may the New Year bring contentment and joy. — **Paul E. Weamer**, Secretary, 5130 Regent St., Madison, WI 53705

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Bill Callahan reports the birth of his first grandson last December. Bill is vice-president and general manager of Philbrick-Booth & Spencer, Inc. . . . **Walt Cook** and his wife are still flying, sailing, and square dancing in Marblehead. . . . **David Grossman** has been in New York City since 1966, where he has served as N.Y.C. deputy budget director, N.Y.C. budget director, comptroller of Chase Manhattan Bank, Russell Sage Foundation visiting scholar, and president of the Nova Institute. . . . Betty and **Fred Lehmann** are constructing a new home in Truro designed by **Dan Sullivan**, '51.

Bernard Rothzeid has been awarded a grant from the National Endowment for the Arts for a study of the chattel houses of Barbados. Bernard's firm, Rothzeid Kaiserman and Thompson, P.C., received the highest honor award from the American Institute of Architects in June, the third successive year in which the firm received the award. . . . **H. E. Knipmeyer** is currently programs manager of corporate automotive market development at DuPont.

On March 3, 1980, **William A. Krivsky** Became president and chief operating officer of Compo Industries, Inc., in Waltham, Mass. We regret to report the death of **Jose Serrano** in April, 1979. . . . **Roy Weinstein**, professor and chairman of Northeastern University's physics department has been named the 1980 Phi Kappa Phi scholar. He is currently doing elementary particle research at the new PEP facility at the Stanford Linear Accelerator Center. . . . **Fred Weitz** was elected president of the Greater Des Moines Chamber of Commerce. His firm, The Weitz Company, is celebrating its 125th anniversary as general contractors. — **Gregor J. Gentleman**, Assistant secretary, 818 S.W. Ninth St., Des Moines, IA 50309

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Eugene D. Scalera, most recently president of the Foam Product Division of General Tire and Rubber Co., is now president of the Scientific Optical Products Division of Bausch and Lomb Inc., Rochester N.Y. . . . **Burt Richter**, winner of the 1976 Nobel Prize in physics, has been named the first holder of Stanford University's newly established Paul Piggott Professorship in the physical sciences. Burt is one of the world's leading elementary physics experimentalists who shared the 1976 Nobel Prize in physics with Samuel C. C. Ting of M.I.T.; he's been a member of the Stanford faculty since 1956. . . . **Darrell A. Frohrib** was selected with ten other mechanical and chemical engineers to visit the People's Republic of China to give biomedical engineering lectures at the Chinese Academy of Sciences in October, 1979.

Richard H. Silverman writes that he has moved to Norwalk, Conn., where he still operates Richard H. Silverman and Associates, providing consulting services in physical distribution, as he has been doing for the past 25 years. . . . The new operations manager-control products for the Instrument and Control Division of Rexnord, Inc., Milwaukee, is **William H. Lane**. Bill is responsible for planning and coordination of the activities of the control products plant. Prior to this appointment, he was an engineering manager with the Switchgear Divi-



Dominik A. Sama, '54, was one of 30 of his classmates who served as ushers at the Inauguration of Paul E. Gray, '54, last September 26 — but with a difference. From his vineyard in Groton, Mass., Mr. Sama brought along a case of an "Inauguration Special" vintage of his "Chateau Lateque" label. It was served at the head table of the Inauguration luncheon (where it obviously made a hit with Howard W. Johnson (left), chairman of the Corporation), and the rest of the case awaits the Grays' pleasure in the President's House at 111 Memorial Drive. Meanwhile, Mr. Sama is at work on a "30th Reunion Special" for 1984. (Photo: Bradford Herzog)

sion of Siemens-Allis, Inc., West Allis, Wisc. Bill and his wife Patricia live in Waukesha, Wisc.; they have two children. Major-General (Reserves) **Amos Horev**, president of Technion-Israel Institute of Technology, delivered the 1980 Jacob Kurtz Memorial Lecture at M.I.T. last spring, on the subject of "Higher Education in Israel and its Role in Serving the Country's National Needs." General Horev, who has been president of Technion-Israel Institute since October 1973, has held a number of senior command and staff positions in the Israeli Army, primarily as chief of the Ordnance Corps (1954-62), when he was responsible for significant advancements in Israel's military capability, and chief of logistics (1968-72). His last military post was as chief scientist to the Israel Defense Establishment. He has served as chairman of the government's Committee on Manpower Requirements for Engineering Industries and as chairman of a public commission to study immigration and absorption in Israel, established in 1976 by the Prime Minister. . . . **Bruce Collipp**'s recent engineering achievements in offshore drilling technology have earned him the Holley Medal, awarded to only 35 individuals in the past 56 years by the American Society of Mechanical Engineers. Bruce, who began his career as an engineering officer on a cargo ship, is known for his work on semisubmersible drilling rigs, starting with the drilling rig Bluewater I. Bruce's ideas have become the basis for a fleet of more than 120 semisubmersible rigs drilling marine leases worldwide, a $2 billion industry. Bruce also worked on the *Eureka*, a conventionally-shaped ship which is the first "dynamically positioned" floating drilling vessel; an underwater manipulator called MOBOT, which was used to complete the first underwater gas field off Santa Barbara; and the first commercial oxyhelium diving bell for transfer of workers to encapsulated wellheads. He has also worked on *Cognac*, the world's tallest offshore platform.

Recently we have been notified of the deaths of two of our classmates. **Sidney Saslovsky**, a Course VI graduate who lived in Medford, N.Y., died on June 22, 1974, and **Conrad D. Kohler**, Kohler, Wisc., died in February 1980 following a short illness. — **Arthur S. Turner**, Secretary, 175 Lowell Street, Carlisle, MA 01741; **Richard F. Lacey**, Assistant Secretary, 2340 Cowper Street, Palo Alto, CA 94301

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As the years pass and our reunion number gets larger, we take notice of the loss of a class member not as an exception or an unlikely accident but as a part of a larger pattern that embraces us all. **David J. Bernays** died on July 6, 1980, after a heart attack at his home. Upon graduation from M.I.T. he served as a fighter pilot in the U.S. Air Force, and earned a masters degree in business administration from Northeastern University. For the past sixteen years he was employed at Armatron Radio Manufacturing Co. as an electronics engineer. Our sympathy goes to his wife Frances and their children Anne and Jonathan.

Allen H. Wahlberg has been named a vice-president of Turner Construction Co. He joined Turner after graduation as a field engineer, and progressed to chief cost engineer, assistant treasurer, and controller in 1973, a position he continues to hold. Allen lives with his family in Ho-ho-kus, N.J., where he is a member of the town planning board.

John T. Sutton was appointed vice-president of

Cianci: A Heart Patient Need Not Live in Mortal Fear

In 1977 **Paul Cianci**, '56, was "about ready to die," with the circulation in three arteries jeopardized, he underwent major open-heart surgery.

Late last year he ran his first marathon — the Ocean State race in Newport, R.I., and after finishing 1,509th in a field of 2,069 he told Bill Parrillo of the *Providence Journal*, "I feel beautiful. . . just beautiful. I almost feel like I could go another 26 miles right now!" Instead he bought an ice cream cone — his first in nearly three years.

Mr. Cianci is a structural engineer, a civil engineering graduate, employed in the Hartford area. Everything was normal until 1977, when he complained of a little shortness of breath. So before going on a ski trip he decided to check in with his doctor.

When it was all over he was like many cardiac patients, he told Mr. Parillo — afraid to take a step. Finally, after lounging around the house for two months, he took control of the problem by enrolling in a cardiac rehabilitation program.

That led first to walking. In six months he was jogging three miles in 30 minutes, in a year he ran his first five-mile race, and by October, 1978, he reached his "safe limit" of a couple of eight-minute miles in a ten-kilometer race. That's half a marathon, and with his doctor's approval he began training for the real thing.

Why?

Mr. Cianci was out to prove something to himself — but even more to lots of other heart patients, he told Mr. Parillo. "I'm not saying everyone should jog or run a marathon. But what I am saying is that a heart patient need not live in mortal fear. Just because you've had a heart attack, it doesn't mean it's the end of your life."

engineering of the Keyes Molded Container Group, which is an operating group of Arcata. He joined Keyes in 1963 as an industrial engineer in the Waterville, Me., office and advanced to the position of manager of manufacturing engineering in 1966. In 1975 he was appointed director of engineering. Earlier, John received his M.S. in industrial management from Stevens Institute of Technology, and was employed for eight years by Alcoa.

Stone and Webster Management Consultants, Inc., has announced the appointment of **Richard L. Forrester** as a director of Stone and Webster Appraisal Corp. Dick is president and chief executive officer of both Appraisal and of the parent company.

William Friedman, Jr., who is the president of Younkers, Inc., was elected a director of Equitable of Iowa Companies, a Des Moines life insurance and retail firm.

Although everyone was at our 25th Reunion, some may have missed rich circuit person **Clyde Spectrum**, who made his fortune from the manufacture of low-calorie bread boards. Clyde has now decided to devote his time to social issues, such as integrated circuits and digital bussing.

Class co-secretaries: **Marc S. Gross**, Winding Road Farm, Ardsley, NY 10502; and **Allan C. Schell**, 19 Wedgemere Ave., Winchester, MA 01890

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A letter from **Al Klainer** brings us up to date on a busy and full life. Al is now M.D., Chairman, Dept. of Internal Medicine, Professor of Clinical Medicine, The Columbia University College of Physicians and Surgeons, Morristown, NJ. His wife, Jo-Ann and he are the parents of three children 17, 15 and 10. He and his wife have co-authored two fiction novels and are presently working on a non-fiction book about adolescents. Al looks forward to hearing from his classmates who "shared the M.I.T. experience."

A press release received from the University of Miami News Bureau announces that **Ralph Warburton**, professor of architecture and planning in the University of Miami's School of Engineering and Architecture, has received a 15-month research grant from the National Science Foundation to study the unique building recertification ordinance operating since 1975 in Dade County, Florida. The author of more than 60 papers, Ralph Warburton has received the national Special Achievement Award of the U.S. Department of Housing and Urban Development.

A newsclip from the *Middlesex News*, Framingham, MA announced the details of a formal Army change of command ceremony at Natick Labs during which Lt. Col. **Eliot Pearlman** assumed charge as head of the Army Research Institute of Environmental Medicine. He returns to this area after serving in both the European and Asian theaters of operations. Welcome home. — **Fred Morefield**, Secretary, Shared Medical Systems, 650 Park Ave, King of Prussia, PA 19406

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Neil Bernstein, his wife Sandy, and their two girls still live in Natick, Mass. Neil is general manager of Valpey-Fischer in Hopkinton. Sandy, who taught for many years, is now Program Director of the Jewish Center. Neil says he and Sandy spend all their spare time on their boat, which is moored near Cape Cod.

A letter from Bette Boyd, wife of **Larry Boyd**, chronicled in one fact-filled page the major events of the past twenty years. For the past 18 years, Bette and Larry have been living in Portland, Ore., where he is vice-president of Fred S. James Insurance. Larry received his M.B.A. from Stanford. Married in 1963 to Bette, they have three sons — John (14), Thomas (11), and Michael (8). Civic interests include the Portland Opera Association, Boy Scouts, and the M.I.T. Educational Council. Hobbies include tennis, snow and water skiing.



Leander Pease, '59

Leander F. Pease III has been re-elected chairman of one of the committees of ASTM. Leander received his B.S. in Course VIII and then switched to Course III for an M.S. and Ph.D. He was a Ford post-doctoral fellow in 1943 at Tech, and received an M.B.A. from Northeastern in 1968. Leander is president of Powder-Tech Associates, Burlington.

June and I are planning a five-week trip to Hong Kong, People's Republic of China, and Japan. It should be an exciting trip.

I don't believe I ever included the names of our class officers in this column, so there they are. **Arthur J. Collias**, 24 Hemlock Dr., Canton Mass. 02021 is President. **Allan S. Bufferd**, 8 Whitney Rd., Newtonville Mass 02160 is executive vice-president. Vice-presidents are **Walter J. Humann**, 3131 Lovers Lane, Dallas TX 75225 (for the Southwest); **Robert D. McAuliffe**, 363 S. Irving St., Ridgewood, NJ 07450 (East Coast); **Robert Muh**, 907 Chantilly Rd., Los Angeles, CA 90024 (West Coast); **David W. Packer**, 31 Great Rd., Bedford, MA 01730 (New England); **Adul Pinsuvana**, Jalan Kertanequara, Jakarta, Indonesia (International); **Thomas D. Tyra, Jr.**, 121 Bayberry Rd., Longwood, FL 32750 (Southeast); and **Martin E. Zimmerman**, 2856 Sheridan Place, Evanston, IL 60201 (Central). Bob Muh and Adul are also assistant secretaries which means that if you write to them, they will pass the information on to me. In fact, any officer will get word to me on class activities. Continuing with this list of officers, there are also **Charles O. Staples**, reunion chairman, 38 Greenwood Rd., Wellesley, MA 02181 and telethon chairman **Joseph D. Zimmerman**, 5335 S. Dentwood, Dallas, TX 75520.

Keep in touch — **Larry Laben**, Secretary, 310 Rockrimmon Rd., Stamford, CT 06903

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Hello, **Noel Bartlett** here, kicking myself for missing my first class reunion. Unable to defend myself, I was "volunteered" by my former roomies **Tom** 'Big Green Turtle' **Farquhar** and **Ray Harlan** (nickname censored) to be class secretary. Rest assured that I will attend the 25th Reunion, and visit some unspeakable horror upon Tom and Ray.

Among those in attendance at the reunion was class psychologist/sociologist/pollster **Tim Hart**. He had managed to con 105 of the class of '60 to answer the questionnaire he had sent out. None of the respondents admitted to having any grandchildren, so I guess we're not really so old, yet. I'll have other interesting insights into our class profile for later issues when (if) I'm short of news on individual class members.

Ray Harlan, when not thinking of odd jobs for yours truly, is an aero engineer at Draper Labs who also designs, builds, and flies indoor model planes. He was a member of the U.S. team which won the world championship for his class of models this past summer in French Lick, Ind. The May 1, 1980 issue of D-Notes, the employee publication of Draper Labs, has an extensive and fascinating article about Ray.

Tom Farquhar, perhaps the "Mr. M.I.T." of our class by virtue of his long and active involvement with the Alumni Association, sends along news of **Chris** and **Linda (Greiner) Sprague**. Says Tom, "Chris is at the Cambridge Nursing Home, 1 Russell Street, Cambridge, MA 02140, after more than three years of hospitalization because of a massive stroke. His ability to communicate is impaired, but not his interest in what everyone is up to. Drop him a line and fill him in." Linda, professor of operations management at the University of New Hampshire's Whittemore School of Business, left for China in August to become one of seven founding professors of the Chinese National Center for Industrial Science and Technology Management. She was selected by the U.S. Department of Commerce to assist the government of the People's Republic of China in establishing the center in Dailien, China. She began teaching an inaugural 18-week program on August 18.

Rosaria Piomelli is the new dean of the School of Architecture and Environmental Studies at City College of New York. She is the first female

architecture dean in the United States. In an interview with the New York Times News Service, Rosaria noted that only three percent of the registered architects in the United States are women. With role models such as Rosaria, this field, too, should benefit from increased participation by women. Three cheers for the women of the Class of '60!

Also on the architecture front, the firm of Samuel Paul, Architect, has changed its name to



David Paul, '60

Samuel Paul and **David J. Paul**, Architects. Samuel graduated from M.I.T. in 1935 and David in 1960. Samuel founded the firm in 1940 and David joined in 1963. The firm is located in Forest Hills, N.Y.

Larry Elman writes his regrets at having to "miss the reunion this time because our home is still wall to wall boxes after our move from California to New York on Memorial Day weekend. In California I had been with Hughes Helicopters in charge of Mission Equipment Coordination, and am now with Fairchild-Republic on Long Island in the Advanced Products Directorate. I'm still actively involved in aviation history and the Bradley Air Museum, even though the outdoor display was totally destroyed by last October's tornado (the museum is still open and functioning). Visitors (and, more importantly, DONATIONS) are earnestly solicited. Anyone from '60 in the middle Long Island/North Shore area who would like to renew old acquaintance, please contact us." (Joan and Larry Elman, 4 Kingfisher Drive, Smithtown, NY 11787 (516) 360-8849).

Dr. **Richard E. Blahut** has been named an IBM Fellow for innovations in advanced direction finding, signal identification and secure transmission techniques. He works at IBM's Federal Systems Division Laboratory, Owego, N.Y. As an IBM Fellow, he may pursue research, scientific and technical projects of his own choosing for five years. . . . **John E. Yates** is co-author of an article in the July/August 1980 issue of *Bell Laboratories Record*, entitled "Powerful Features for a Small ESS." John is supervisor of the rural and suburban data base group at Bell Labs in Naperville, Ill.

William M. Hawkins writes that he "made a midlife career change" to manager of systems engineering for Rosemount, Inc. Industrial Process Systems, and has moved to Minneapolis, Minn. . . . **Howard C. Meadors, Jr.**, relates that he has "spent much of the spring of this year in London where I have been functioning as technical adviser and expert witness in a patent infringement lawsuit at the Royal Courts of Justice." . . . **Robert E. de Michaels** writes, "I am completing a three-year tour as Commander of the Elmendorf AFB Weather Station in Anchorage. My retirement, after 20 years of active duty, was approved in August. We hope to return to the Denver area once our home sells and embark on a new career. We're looking forward to renewing friendships and actively participating in the Denver M.I.T. Alumni organization."

Gordon S. Mutchler reports that he is "very busy with an experiment on nucleon-nuclear scattering. Lynn is working as a data base manager for the M.D. Anderson Hypertension Center." . . . **James Nicholson** says, "My wife Kathy and I live in Lincoln, Mass. I am senior program manager at a 30-man "M.I.T.-based" engineering company, AMTI, Newton, Mass. Kathy is vice-president of human resources at Star Market. We are expecting a baby in August and are delighted."

Morris Salame reports that he is now manager of the new product development department of the plastics division of Monsanto. He's celebrating 20 years with Monsanto. . . . And, **Ray Gumb** says, "Mary Ann and I are enjoying sunny southern California after many years in the Philadelphia area. Mary Ann is working on data bases for Burroughs, and I am teaching computer science at CSUN. My second book, *Evolving Theories*, has just come out."

Along with the good news comes some bad. I have learned that **Charles L. Livingston** died last February. His degree was in aeronautical engineering and he was employed by Textron, Inc., Fort Worth, at the time of his death.

That's it for now, except to extend the appreciation of the entire class to out-going secretary **Bob Stengel** for handling these class notes the past five years. Enjoy your retirement, Bob. Hope to hear from all of you. — **Noel S. Bartlett**, Secretary, 15320 Edolyn Ave., Cleveland OH 44111

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Barbara and I passed a quiet summer. Our two daughters, Amy and Laura, spent their fifth summer at camp in Connecticut. Amy, our oldest, is 15, and she and a number of other girls made a trip to Boston to visit some of the colleges. Their itinerary didn't include M.I.T., but Amy pointed it out to her friends. One of our backpacking trips to the Sierras was snowed out (in July!), but we went for eight days in August to a spot just north of Mt. Whitney. Yours truly caught a lot of fish, but most were rather small; the few "keepers" only amounted to hors d'oeuvres at lunch. How were your summers — or can't you remember that far back? Now to the news.

Pete Van Aken received a promotion to vice-president of administrative affairs at Brandeis University. He had been v.p. for budget and analytical services. In his new job, Pete will have responsibility for plant operations, employee relations, campus police, purchasing, data processing, and other administrative support activities. He, Carol ('65), Christina, 5, and David, 1, are still living in Winchester.

A news clipping informs us that **George Bryant** made a trip last June to tour industrial sites in Dearborn, Mich. with the Society of Industrial Archaeologists. George is doing his own industrial archaeology by digging up and rebuilding an ancient saltworks in his backyard in Provincetown, Mass. George is also a selectman in Provincetown. . . . **Walter Berninger** has been appointed manager of the Power Semiconductor Branch at the General Electric R&D Center in Schenectady, N.Y. Walter's group explores applications for power semiconductors in sophisticated drive circuits for motors, ac/dc conversion, and power conditioning, among other activities. He has been with GE since 1971, and in 1978 was cited by GE for his contributions to the development of GE's advanced computer tomography X-ray scanner.

Finally, a real letter from Toby and **Bruce Eisenstein** informs us that Bruce was recently made head of the Department of Electrical Engineering at Drexel University. The department is a large one, with 28 faculty members, 900 undergrads, and 250 graduate students. Bruce has many ideas for the department and has been attacking his new duties with gusto. The Eisensteins remark that their children are getting so large so fast (ah, it happens to all of us!) — Eric is 9½, Andrew is 8, and daughter Ilana is 3. Well, that's all there is, folks. More next month. — **Mike Bertin**, Secretary, 18022 Gillman St., Irvine, CA 92715

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Greetings '64. This is a reasonable month for news with a sprinkle of press releases and class heroes. Dr. **Daniel F. Blossey** has been named manager of advanced marking for Xerox Corp's Reprographic Technology Group in Webster, N.Y. He is responsible for the management of non-xerographic electronic printing and copier/duplicator technology development.

Intel Corp. of Santa Clara, Calif. has named **Laurence Hootnik**, senior vice president of Finance and Administration. . . . GTE has announced the appointment of **John P. Downie** as general manager of the Sylvania Connector Products Operation in Titusville, Pa. Since 1971, he has been vice president and general manager of GTE's Asheville Plastic Services, Inc., Asheville, N.C.

Class hero **Bob Gray** has written to catch us up on what he's been doing the past two years. The Gray family — wife, two kids, a dog, two cats, and a horse — are still living in La Honda, Calif. Bob was promoted to (full) professor of electrical engineering at Stanford University and elected as a fellow of IEEE for "contributions to information and communication theory"; he is also editor of the IEEE *Transactions on Information Theory*. Bob passed his advanced class amateur radio license exam (KB6XQ) helping him to "not get continually embarrassed by know-it-all hams in my modulation courses." His one failure: "after 10 years I still remain a lowly fireman on the La Honda Volunteer Fire Department. Perhaps someday I will make lieutenant." Thanks for the update, Bob!

Our other class hero is **Jim Lerner**. Jim and Judy are the proud parents of Zachary Ian, their first child and a joy to them both. Jim wonders if he'll be a scientist or engineer, and if he got accepted at M.I.T. in the fall of 1997 could he/we afford the fees? We all seem to worry about that! Jim is senior technical advisor for the Wind Energy Program of the California Energy Commission, where he has been for five years. The Commission's goal is to produce 10 percent of California's electrical energy needs in the year 2000 by wind energy. Last June Jim was honored by the American Wind Energy Association at their annual conference. He received an award of excellence for contributing to the "vision of wind energy in California."

Our trip to Bermuda was, as usual, fantastic with beautiful weather and water, lovely and friendly natives, and a relaxing and restful environment. The kids particularly loved the hotel's childrens program (they saw much more of the island than we did, but we had been there before). Our oldest son was enough of a "mensch" (check with a Jewish friend for translation) to thank us for his wonderful summer! I have been promoted to group vice president (responsible for two divisions), at ManTech International Corp. which continues to grow and prosper with each passing year. The D.C. area has been a five-year whirlwind for us so far, and we love it (though I still like New England best of all the places we've lived, a distinct minority opinion of our family, lacking even the the support of my native New England wife).

Marlene and I went to Brugge, Belgium in October to attend the semi-annual IEEE ATLAS Committee meeting (ATLAS is a standardized test language for describing test procedures and test programs). I'll tell you about it next time. Stay well and write!!! **Steve Schlosser**, Secretary, 11129 Deborah Dr., Potomac, MD 20854

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James Bochnowski has resigned as president of Shugart Associates, a disk drive manufacturer and Xerox subsidiary, in order to participate in the formation of a venture capital firm.

Ralph Cicerone has been named director of the Atmospheric Chemistry and Aeronomy Division at the National Center for Atmospheric Research in

Sunlight vs. Uremic Pruritus

Itching — no rash, just itching — is a frequent accompaniment to kidney and liver disease, lymphomas, hyperthyroidism, and even pregnancy. Uremic pruritus it's called.

A simple cure: sunlight — the proposal of Dr. **Barbara A. Gilchrest**, '67, dermatologist at Beth Israel Hospital, Boston.

Research at Beth Israel has already established that ultraviolet light threrapy gives "dramatic, long-lasting relief" of itching among sufferers of chronic kidney failure who require hemodialysis. Ultraviolet treatment was administered one to three times a week in a light box with ultraviolet illumination, with doses 75 per cent of the amount needed to produce sunburn.

Now Dr. Gilchrest — she's co-author of a new guide to skin care called *Between You and Me* — will test ultraviolet as a treatment for the itching which accompanies other human ailments.

Boulder, Colo. Ralph has been a research chemist at the Scripps Institute of Oceanography and is best known for his work on photochemical processes that can damage the earth's ozone layer. In 1979 Ralph received the James B. Macelwane Award of the American Geophysical Union for significant contributions to geophysics by an outstanding young scientist. Ralph is also co-editor of the *Journal of Geophysical Research*.

Richard Ayers is the new executive vice-president and general manager of Mac Tools, Division of the Stanley Works in New Britain, Conn. He has been with Stanley since 1972 and has been manager of plant operations since 1976. . . . **Dick Schwarz** has been named senior research chemist, Technical Center at PPG Industries' Barberton, Ohio, Plant.

Anne and I had dinner Saturday night with Brenda and **Matt Mleziva**. Matt is still a civilian employee at the Air Force Electronic Systems Division at Hanscom Air Force Base in Bedford, Mass., and is now in charge of the corporate planning function there. Brenda just got her teaching certificate and is continuing graduate work in education at Lesley College in Cambridge. My new assignment with MITRE puts me in the same building with Matt at Hanscom, so my current project is to convince him to take up noontime jogging with me. — **Steve Lipner**, Secretary, 6 Midland Rd., Wellesley, MA 02181

66 15th Reunion

Roy F. Schwitters, professor of physics at "the other" Cambridge University was selected by the National Science Foundation for the 1980 Alan T. Waterman Award, an award for which there were 116 nominees; it carries a $50,000 a year research grant for a three-year period. Roy is a high-energy physicist. Congratulations! Along a similar vein, **Alexander Sawchuk** has distinguished himself by earning a 1980 Halliburton Faculty Award at the University of Southern California College of Engineering, where he is associate professor of electrical engineering. Congratulations!

Two more classmates are joining the entrepreneural ranks: **David Nicoli**, who is assistant professor of physics, University of California at Santa Barbara, specializing in laser and flourescence techniques applied to biophysics and medicine, has started Nicomp Instruments developing and marketing small scientific instruments. **Logan Donnel** founded Logan L. Donnel Associates, Inc. consulting engineers in Boulder, Colo.; he and his three associates have a nationwide practice specializing in "building pathology" (especially roofing and other remedial design). He, his wife, Dathryn, and sons Jonathon and Jed have lived in Boulder over three years.

Eleanore and **William Klepser** have joined the "jet" (or at least airborne) set recently when Bill received both his instrument and commercial pilots' licenses. They have logged over 5,000 miles in the past year visiting family and friends. We wish them the best of flying and I especially pray for their safety. Eleanore once agreed to join the Class of '66 secretary rotation. This year is a rotation year and her chance to carry on.

William Maselunas has joined the firm of Loomis, Sayles and Co. as an investment analyst. . . . **George F. Leslie, Jr.**, was recently promoted to president of VSC Corp. (Congratulations!); he is currently licensing a patented "speed compression" technology to leading manufacturers of audio and video equipment. . . . **Lee Casperson** has been promoted to full professor in the Electrical Sciences and Engineering Department at the University of California at Los Angeles; Lee and his wife, Susie, have two daughters, Julie, and Janet. . . . **Bert Barrington** writes that he is in the Minnesota northlands, having recently completed a new eye clinic in Watoma, Minn.

Jack Fuhrer is still busy working for RCA Consumer Electronics as an engineering manager. He finally finished construction on an Ethan Allen "eat-your-heart-out wall unit" after three years and has discovered water skiing.

I have enjoyed writing the notes these past two years and I hope to see many of you at the class reunion next spring. Be sure you help Eleanore keep your news in the column. Best wishes — **J. Patterson**, Secretary, 1403 Gerard St., Rockville, MD 20850

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Allen Gammon lives in Akron, Ohio, designs tires, and travels the Formula I racing circuit for Goodyear. In lieu of going to the annual Corvair convention, Allen and Tim Kjellberg, '68 met in Minneapolis for a vacation last summer. Tim is living in Scottsdale Ariz., and working for Air Research in Phoenix. Allen's wife, Julie, and Tim's wife, Betty are both librarians. . . . Mona and **Tom Jensen**, who live in Hampstead, N.H., have switched traditional roles — Tom is the fulltime homemaker of the family and is chiefly responsible for Carla, 8, and Aaron, 5, and Mona,'66, holds a supervisory position at Instrumentation Laboratories in Andover. . . . **Keith Patterson** recently joined Ketchum Medical, the health care advertising unit of KM&G International, Inc., as creative director. He lives in San Francisco. — **Jim Swanson**, Secretary, 878 Hoffman Ter., Los Altos, CA 94022

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First, we would like to apopogize profusely for having blank space in this column so often in the past few months. We are finally settled down from both moving into very hectic jobs in the past year and pledge better performance. The message was made very clear recently when I visited Ruth and **Rich Lufkin** at their new house in Basking Ridge, N.J. Ruth thrust in front of me a copy of the *Review* on which she paid postage due (because of their move from Wellesley), and demanded better performance. (Incidently, the reason they moved to New Jersey is that Rich took a new job as venture manager for Johnson and Johnson in New Brunswick.)

We got a long letter from **Carolyn (Henry)** and **Gary Bjorklund** with the following details: "After 10 years we thought it was about time to bring all our friends up to date on what we're doing. For the first time, Gary and I are both working, a pleasant increase in our standard of living. I worked in physics and computer science while Gary was in the Army (drafted — remember the old Vietnam-era days?) and graduate school at Stanford in laser physics. Then Gary worked at Bell Labs in New Jersey while I went to graduate school at Princeton in computer science. Eastern winters seemed to get colder and colder, so we opted to return to sunny California after I got my Ph.D. Gary's now working at IBM's San Jose Research Lab in laser spectroscopy and I'm working at Lockheed Palo Alto Research Labs on pattern recognition and scene analysis. Gary's finding that any day is a good one for jogging and I'm getting back into duplicate bridge playing, hoping to become a life master soon. We invite any of our old friends to look us up if you are in the Los Altos (Palo Alto) area."

Back east, **Ken Rosenberg** has become a partner in the firm of Mesirov, Gelman, Jaffe, Cramer, & Jamieson in Philadelphia, specializing in real estate law. He has also been appointed to the M.I.T. Educational Council. . . . Farther north, **Michael Weinreich** is still living in Arlington, Mass. — divorced, no children, one cat. While he doesn't have a full-time job, he's "doing fine" as an independent consultant, primarily involved with the development of computer based engineering analysis methods. . . . Last winter **John Vitek** started a new job at Oak Ridge National Laboratory.

Back in the west, **Richard Zvonar-Griggs** is working on a Ph.D. in music composition at U.C.S.D. in La Jolla and is employed by the Center for Music Experiment as assistant to Professor Dick Moore in the establishment of a new computer music facility. Specifically he is trying to make a new DEC VAX 11/780 "sing tunefully.". . . **Richard Raysman** recently formed a law firm named Brown & Raysman in New York. He is specializing in law relating to the computer industry. He has lectured and written many articles in the field for lawyers and others in the data processing business. . . . Sue and **Dave Ellis** wrote to announce the birth of Sharon Rachael, Class of '01, on August 17, 1979. Dave is still an attorney with Paradyne Corp., a rapidly growing data communications company in Tampa/St. Petersburg. Sue is a psychologist in private practice.

Dennis Noson has started a new career by moving from physical oceanography to architectural acoustics. He finished an architecture degree last year and landed a job with a consulting firm one mile from home. To keep up with the academic front, he's co-authoring a textbook on musical acoustics. . . . While some praise the sunny climates, **James Cormier** writes that he enjoys living and skiing in New Hampshire. He is president of Distributed Systems Corp., Chelmsford, Mass., a management consulting and software development firm.

In the perpetual student category this month we have two entrants. **Ellen Greenberg** is a Ph.D. candidate in organizational behavior at Columbia University Graduate School of Business, and **Paul Ware** is back at night school at B.U. in an M.B.A. program hoping to get into the D.B.A. program. Paul also works at Polaroid in Norwood as a senior quality engineer. **Thomas Romer** spent the last academic year at the Federal Trade Commission, here in your nation's capital. He has returned to his position as associate professor of economics at Carnegie-Mellon University. . . . That's all we have room for now. Please keep those cards and letters coming, and we'll try to print them all soon. — **Gail** and **Mike Marcus**, 2207 Reddfield Dr., Falls Church, VA 22043

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Just attended the World Science Fiction Convention which was in Boston for the first time since 1971. It was a lot of fun but very exhausting, as I averaged about four hours of sleep a night for

five nights.

Not so tiring but also a lot of fun was our 11th Reunion held at the beachside home of Sina and **Tom Najarian**. Total attendance was about 15, including family, with a like number being in touch but unable to come. Pat and **Don Uhle** travelled the furthest, from Connecticut, where Don is still working in nuclear engineering.

Layne and **Jeff Lepes** brought their two children, David and Debbie, and Beth and **Bob McGreggor** brought 2-year-old Amanda. Sina provided more food than we could possibly consume, but it was so good that we all tried. Next year we'll have to start planning a bit earlier and make sure the preparations are spread a bit more evenly.

Larry Lowry, formerly a senior staff member of Boston Consulting Group, has been elected a vice-president to their Menlo Park Calif., office.

Not many people have been in touch, but I haven't moved. — **Robert K. Wiener**, Secretary, P.O. Box 27, M.I.T. Branch, Cambridge, MA 02139

71 10th Reunion

Congratulations to Janet and **Tim Finin** on the birth of their second child Peter born in September 1979 who joins Katie 4. Tim is now an assistant professor of computer and information science at the University of Pennsylvania in Philadelphia. He completed his Ph.D. in computer science at the University of Illinois.

Andrew A. Sabak received his master's in computer science from Nova University, Fort Lauderdale, Fla., and is now a data processing manager with BUC International Corp. Andrew also received a bachelor's in theology from Christ the Saviour Orthodox Seminary, Johnstown, Penn., in June, 1975.

William H. Rastetter was among 78 young scientists who received a two year Sloan Fellowship for Basic Research. Merry Christmas and Happy New Year — **Hal Moorman**, Secretary, P.O. Box 1808, Brenham, TX 77833

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What scanty news this month! But one loyal correspondent, **Igor Frolow**, writes that he received his Ph.D in applied math from Brown in 1978 and has for three years been assistant professor of math at Oberlin. He married Pamela Taylor of San Antonio, Tex., and they are expecting Iggie Jr. ('03). Igor is now a consultant in math at BDM Corp. of McLean VA.

David Bernstein has been named director of computer product development at Data General in Westboro, Mass. We congratulate him on this prestigious position.

And. . . . tarah-tarah!! The big news of the year is yours resignedly's long-heralded plunge into the bonds of matrimony. Wife Ruth and I are pictured on this page, along with the "popes in the piazza." This honor is accorded only correspondents, you know. Word of our new location will follow. P.S. Tony got married last month too, but, his wasn't as good as mine. — **Robert M.O. Sutton**, Secretary, 2005 Cedarwood, Carrollton, TX 75006

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Let's see. . . . this must be near turkey time and somewhere in the days to come we elect one to the Presidency. All I can say is that those of you who weren't registered to vote and/or didn't vote had better keep your mouths shut if you don't like the way things turn out.

The good news: I got a letter from **Chuck Rosenblatt**! He was not afraid to write. After completing his two year postdoc at Berkeley (where he spent most of his time sunning, traveling, and making new friends), he has returned to the Institute (all rise, please, and hum the school song) to set up a program in liquids and liquid crystals at the Magnet Lab, his old undergraduate huant. In early 1979 Chuck went to Seattle to visit **Al Lazzarini**, '74, and view his first solar eclipse (total!).

When he's not playing hockey, Mike Perlmutter, '73, and his wife **Yvonne (Walkowski)** are busy taking care of Sarah Kathryn who was born on July 8, 1980. They all live Sherborn, Mass. which is somewhere beyond the point where I got lost one evening recently.

Walter Frank: how many of you remeber that name? A few months ago, I was in H-----D Square visiting the offices of a small consulting firm that goes by the call letters of PSDI. I was walking by a line printer when this person got up from behind the machine and proceeded to mutilate (actually he was looking for something) a large pile of output. I was speechless: Walter had a haircut, three piece suit, and that liberal patina that takes years for others to acquire. The last I knew, Walter was being held for ransome by a foreign power, but that's another story.

Kin Chu Woo (Junior, as many of us still know him) dropped in from Texas where he is working on his Doctorate in electrical engineering at Texas A&M. Junior is really doing well socially and was giving free advice to **Henry Magno, Jr.** on various techniques relating to high-yield energy curves and thermo-couples of a very "loose" nature. That's basic physics. Junior is very much into applying his years at M.I.T. to the problems of daily living. We should all profit by his example.



Pamela Jackson, '74

Pamela Jackson has been promoted to department chief of development engineering at Western Electric's Hawthorne Works in Chicago. She has been a planning engineer at WE's Engineering Research Center in Princeton, N.J. until her recent promotion and transfer to Illinois. She and her husband John have two daughters Lorri and Judy. She is also the speaker for the Bell System Women and Minorities in Engineering Program.

David Marsh has been appointed director of the Corporate Strategic Planning Department at Public Service Co. of New Hampshire. I would like to quote from the article in the *Suncook Valley Sun* directly dealing with David's new role: "The Corporate Strategic Planning Department will help the company anticipate and deal with changing conditions," Harrison (president of PSC) said. "The company will have specific short and long term goals and a comprehensive plan to reach them. The goals and the company's success in reaching them will be re-evaluated regularly. Overall, the department will add an important new dimension to the company." Good luck, David.

And now a few words about me. I know that many of you avid readers wait patiently month after month just to get some news of me. You could write and ask, you know. Due to environmental hazards and a burning desire not to suffer the same fate as the Titanic (or Ron Ziegler for that matter), I have left DRI for newer pastures. I am now busily having a good time at Canavest, Inc., a small company (12 disciples) located in sunny Dedham, Mass. We are all engaged in turning out a very handy system for money managers who think that we are incredibly talented and fun to work with. In other words: We are really neat! I am still living in sunny downtown Arlington and deeply pondering the meaning of life's big and little pleasures. It's time to put another column to bed. I would like to leave you with a thought: We're all getting older: are things getting any better? **Jim Gokhale**, 12 Pond Ln., Arlington, MA 02174, **Lionel Goulet**, 34 Tremlett Ave. Dorchester, MA 02124



Ruth and Robert Sutton recently celebrated the "long-heralded plunge into the bonds of matrimony." Mr. Sutton is secretary for the Class of 1973.

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Fall has finally flown in, filled with its fruity flavor of flaming forests and flowering philodendrons. But let's forget foolish fun and focus on the facts: **Sandy Kelly** got married last June 21. He writes: "We will spend part of our honeymoon traveling cross-country by motorcycle." After teaching for several years he went back to school (Drexel U.) and got a master's degree in applied math; his new job involves doing research work at Siemens Corp. . . . **Michael Stiefel** married Susanna Haberman, a graduate of Brandeis University, on May 25, 1980. . . . **George Herman** is a financial analyst at DEC. As to his spare time, George writes: "I spend most of [it] perfecting my DND Dungeon — elves beware!!"

David S. Kelly writes: "Onward and upward (?). I'm now in a house and a job I plan to keep for some years! Deborah and I bought a second house in December 1979 — a great old Spanish-style place with room to move around. And, as of November 1979, I work for the Mouse (Mickey, that is). I'm a senior programmer at Walt Disney Productions, working on software systems for ride control at Disneyland and Disney World. A magical place to work!" . . . **Chris Dippel** writes: "Chris Santos (Wellesley, '74) and I are gainfully employed at last after too many years of graduate school. After a brief internship with the office of cancer communications of NCI, I got a job with a Washington consulting firm."

Diane McKnight says: "I finally left the Institute in July 1979 when I finished my Ph.D. thesis in environmental engineering. Larry Esposito and I are

enjoying living in Colorado. I have a postdoc with the U.S. Geological Survey where I've been studying acid mine drainage in the Rockies and the ash from the Mt. St. Helens volcano." . . . **Richard H. Granger, Jr.**, reports: "I've finished my Ph.D. in computer science at Yale and am now an assistant professor of C.S. at the University of California at Irvine. Too far away to reune [sic], but I send greetings to the old crowd: Ron, Russ, Joel, Ken, Big and Little A, and all the rest."

Paul D. Husby tells us: "In January I returned to M.I.T. to join the Concert Band for their winter tour. Upon the last minute hospitalization of John Corley, I took over the conducting duties and led a very successful week-long tour of the midwest, including two world premieres. I am now busy managing commercial property in Minneapolis." . . . **David R. Katz** writes: "I've been with Burns and McDonnell in Kansas City for a year now, and I've found that it is the engineer who runs the show at an architecture/engineering firm. I've started night school to get an M.S. in engineering through a program run by U.Kansas. It is run in suburban K.C. in a 'baby-boom' elementary school that K.U. purchased from the local school district when the school age population declined." I hope David doesn't have to sit at one of those tiny little desks we had when I was in elementary school. . . . **Margaret Hainsworth** has received a branch manager's award from IBM. Her career appears to be advancing by strides.

Robert C. Laureson obtained an S.M. in electrical engineering in 1977 and an S.M. in management in 1980, both at M.I.T. As befits a Sloan School graduate, he plans to go into financial consulting. He adds: "I'm also sharpening my lacrosse game for a comeback this summer in the B.U. Summer Lacrosse League." . . . **Michael S. Cucchissi** testifies as follows: "I have completed my clerkship with Chief Judge Samuel P. King of the U.S. District Court of Hawaii and am now an associate with the Los Angeles law firm of Gibson, Dunn, and Crutcher at their Newport Beach, Calif., office." . . . **Michael Lebowitz** (Yale Ph.D., '80) will be an assistant professor in the new department of computer science at Columbia starting this fall. His field of interest is artificial intellegence, natural language processing in particular. . . . **Alan Levin**, M.I.T. nuclear engineering Ph.D. is working at Oak Ridge National Lab on LMFBR safety.

David R. Martin graduated from Stanford Business School last year. He joined Conrail in Philadelphia, Penn., and is now manager of planning for gondolas and flatcars. . . . We learn from **Mark Matteucci** that he is "currently teaching home economics at a local junior college and selling insurance on the side." . . . **Ibrahim Hasan** writes: "I am finishing my Ph.D. program in economics at U. California, Berkeley this summer, and we are going back to Jakarta right after that."

That's all for this month. Feel free to write; if you aren't quite sure what to say, may I suggest the following outline: name, address, occupation, latest accomplishment, most recent book read, a brief statement of your personal philosophy, and finally the name of your favorite scotch. — **Alex Castaldo**, Secretary, 929 Mass. Ave. (12D), Cambridge, MA 02139

76 5th Reunion

From the mails, we have a note from Helene Mayer, wife of **Ken Virgile**. Ken has left Datatrol and is now employed as a software consultant with Datasphere of Lincoln, Mass. Helene is attending Boston University School of Social Work.

While attending a cocktail party at the M.I.T. Club of New York, I had the pleasure of seeing **Jeffrey Halis**, a foreign exchange consultant with Citibank. We had a good time discussing the move in West German marks, which your secretary had also been speculating in. You never can tell where commodities people will turn up! Jeffrey is having a very interesting time with Citibank, operating on a scale most people have difficulty in imagining.

Gary Buchwald got a speeding ticket on Martha's Vineyard, of all places. Gary went to court, defended himself, and *won*. Our congrats for a well-done effort.

Your secretary had a weekend rendezvous in Mystic, Conn. While buying a Sunday *New York Times* to read on the train back, who did he find behind him in the line but **Peter Kaufman**, M.D. Peter had not changed one bit since graduation, except for a shorter haircut. He is now an intern at Roger Williams Hospital in Rhode Island. He especially enjoys having some leisure time, for he had none as a student, he says. It was a pleasant suprise for each of us, a nice way to conclude a weekend.

Erland van Lidth de Jeude reported that he was participating in his first strike (Screen Actors Guild) and not enjoying it. Fortuately he does computer consulting as well; otherwise, it would be not-so-slow starvation!

As for your secretary, he has developed a fondness for one of the Four Horsemen of the Apocolypse — Famine. In particular, the results of this summer's drought. He is sitting on a mountain of corn and oats and is comfortably waiting for an official U.S. government report on crop yields.

Send your secretary some news. He enjoys the company of the Four Horsemen, but your news world provide some perspective and balance. — **Arthur J. Carp**, Secretary, Sandro Rohstoff, Inc., 1 World Trade Center, New York, NY 10014

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Hello again! Mail is finally starting to trickle (and I do mean trickle!) in, so here is the latest on your classmates. . . **Debbe Utko**, having settled on the west coast, sent me a long letter to update me, not only on her own activities, but also on the activities and whereabouts of many of her friends. (Now that's the spirit!) Debbe is currently living in the Nob Hill area of San Francisco, and, as of the time of the letter, just getting to know her way around the city. Her work is with Chevron Chemical in technical marketing and she is sharing an office with another M.I.T. graduate — Jean Singer, '79.

Debbe asked me to report in the Class Notes column on the performance of the Women's Crew Team in the Women's National and Collegiate Rowing Championships. While this column would normally not be a forum for such news, this proves to be an exception. The team, competing in Oak Ridge, Tenn., in late June, had seven (count 'em!) Class of '80 members on it, in addition to the coxswain (Debbe). The other members of the boat were **Sandy McCarley**, **Adra Smith**, **Kathy Dutrow**, **Diane Medved**, **Liz Fisher**, **Joan Whitten**, **Laura MacGinitie**, and Wizzy Markham '81. The team won the petit finals in the Collegiate Eight event, and finished in third place (in a field of 18) in the Senior Eight event (this time with Anita Sircar, '82, as coxswain). Debbe notes that, ". . . these people have been rowing together for four years, and this is the best the team has ever done." Congrats to all!

Russel Blount, **Mike Nuttall**, and **Ed Gillett** drove down to Tennessee to watch the races. Russ, apparently, opted to be a women's crew spectator instead of searching for a job. A wise choice in my opinion. . . As for the aforementioned crew people, most of them seem to be opting for continuing their educations. Laura, Diane, and Liz are all staying at M.I.T. — Diane and Liz looking for advanced degrees in chemical engineering and Laura going into the electrical engineering department. Joan is starting studies at Harvard Medical School, and Kathy has set off for Beaver Falls (no relation to M.I.T.), N.Y., where she will be working for Boise-Cascade Co.

Debbe also writes (I think she wants to take over my column!): "While in Tennessee, I visited with **Wes Asbury** and family, who showed some superb southern hospitality. Wes is going to work for Union Carbide in Oak Ridge as soon as his security clearance comes through. . . . While spending time at home in Armonk, N.Y., I lunched a few times with **Terry Ravese**, who since January has been working at American Can and will be attending Northwestern University School of Business Administration. According to Terry, the working atmosphere is a bit like Peyton Place and the work itself, well, what can be said about computer programming?" Hey, I resent that remark, Terry. . . eh, I think. . .

"I also had the pleasure of visiting **Tabetha Frey** at her dad's summer home in Martha's Vineyard. Tabetha made a brief jaunt to Dallas, Tex. during the peak of the heat wave to visit Don Lampe, '78. Tab will be working on Wall St. for Chemical Bank for a year and then will go to Wharton School of Business."

Other classmate whereabouts that Debbe has compiled include: **Nancy Cho** and **Mike Schiffman** at N.Y.U. Medical School. . . **Andy Edelman** in a Ph.D./M.D. program at N.Y.U. . . . **Leslie Newman** at Sloan for one more semester to get her M.B.A. . . . **Terry Weston** at Caltech for a chemical engineering degree. . . **Cammy Abernathy** in a Ph.D. program in materials science at Stanford University. . . **Mark Vershel** at M.I.T. in computer science. . . **Gary Smith** and **Jeff Bergenthal** in the army. . . **Bob Stone** and **John Bard** in the air force. . . class president **Chuck Irwin**, as well as **Ralph Hulseman**, **Ricardo Sitchin**, **Dick Baars**, **Tom Griffin**, and **Charlene Chuang** enrolled in M.I.T. chemical engineering practice school.

Mark Karlen, **Paul Homsy**, and **Tim Morganthaler** are all at medical school. Mark is enrolled at the University of Virginia, Paul at the University of Texas, and Tim at Dartmouth. . . **Larysa Kulynych**, **Janice Antoine**, and **John Dolan** are working on advanced chemical engineering degrees. Larysa is at the University of Rochester, Janice is at the University of Penn., and John opted to stay at M.I.T. . . . **Marion Rideout** is in geology at the University of Rhode Island. . . . **Donna Bielinski** is staying in town and going to Boston College in biology. . . . **James Garner** is in a civil engineering program at Northwestern University. . . . **Ray Nagem** is at M.I.T. in mechanical engineering.

Sue Stultz is now working for Watkins-Johnson in Palo Alto, Calif. . . . **Lucia Chen**, also in California, is working for Signetics Corp. in Silicon Valley. . . **Lisa Oberg** is in Boston, working for Prudential Insurance. . . In the oil business we have both **Tom Glow** and **Frank "Fiji" Cariello** going down to Edison, N.J., to work for Mobil. . . **Gerry Applestein** is working for Exxon near New Orleans, La. . . . **Jeff Tyrell** moved to Texas to work in Texarkana. As of this writing, Jeff's wife Marianne, was due to give birth. Let us know if it is a boy or a girl, Jeff.

All of the above news came from Debbee Utko. Thanks again, Debbe. Anyone who would like to try to match her feat is more than welcome to try. Just to let you know that I haven't been sleeping for a month though, I have managed to come up with some of my own news:

Charlie Hoffman writes that he and Linda Lepnis, '82, have tied the knot and are currently living in Eastgate until Linda graduates. Congratulations, Charlie and Linda, and best of luck for the future! Charlie, in the meantime, has started Ph.D. work at Tuft's microbiology and molecular biology department.

Jeff Thomas is starting graduate work in computer science at the University of California at Irvine. . . . **Kate Mulroney** is currently doing management consulting work in Harvard Square. . . . **Bill Springer** made a couple of Rhode Island newspapers in July when he was named the new Warwick tax collector. Bill will be working on improving public relations. I don't know what the tax collector's office is like in Warwick, Bill, but if it is anything like the tax offices that I have had to deal with, then you have quite a job ahead of you!

That's it. All the news that fits is print, so keep on writing. — **Ken Turkewitz**, Secretary, Bldg. 15, Apt. 2D, 241 Lexington St., Woburn, MA 01801

Under the Domes



Speaking at M.I.T. on September 25, Vice-President Walter F. Mondale promised "a long-term national commitment to our research centers." The pledge was music to the ears of many in his audience, including Howard W. Johnson (right), chairman of the Corporation, who introduced Mr. Mondale to a standing-room-only crowd in Kresge Auditorium. (Photo: Calvin Campbell)

The Vice-President Calls for a New Deal for the Universities

". . . There is scarcely a task America faces that can't be met without new respect and increased support for our finest research universities."

When that statement comes from the vice-president of the U.S., and when he adds that M.I.T. — his host of the moment — "has set standards of teaching and research admired by universities everywhere," the appearance of Walter F. Mondale in Kresge Auditorium on September 25 has to be added to the sources of the pride and uplift which were transfused into the entire M.I.T. community during the last week of September. (Mr. Mondale's appearance was billed as "nonpolitical" by his office, and it was not part of the official Inaugural events.)

"The surest route to new discoveries is to support our major research centers, protect their academic freedom, help them get the equipment and talent and facilities they need, and leave them alone to their job," Mr. Mondale said.

The vice-president described three problems as most critical:

☐ People. "If universities lose their critical mass of researchers, both the campus and industry will be diminished. . . . If we do not act, we will be in danger of losing an entire generation of researchers in key fields.

☐ Tools. Facilities and libraries are too old and too small. "It is time to make our equipment catch up with our minds," said Mr. Mondale.

☐ Clout. "Universities and industry must cooperate as never before," said Mr. Mondale, recalling a few of the countless examples of how university research has opened industrial frontiers.

For all these reasons, the White House has proposed a $600 million program for U.S. research and technological development — a "national commitment to our research centers," Mr. Mondale called it.

Though most of the newsmen assigned to the vice-president seemed to Robert B. Host, '81, of *The Tech* to be sitting on their hands, it was different in the audience. Vice-President Mondale and his capacity crowd in Kresge "would have liked to talk for another hour," said Howard W. Johnson, who as chairman of the Corporation was the vice-president's M.I.T. host.

After Fear of Red Ink, 1979-80 Shows a Tiny Surplus on $418 Million Operations

M.I.T. finished the year 1979-80 in the black — a surplus of $376,000 of total operations of $418 million — the highest ever. For the current year (1980-81), says John A. Currie, director of finance in the office of the vice-president for financial operations, total budgets are over $451 million and there may be a shortfall of $800,000.

The 1979-80 results compare very favorably with the $2 million deficit forecast by President Paul E. Gray, '54, in reporting to the faculty as chancellor a year ago. The good news is the result of an unexpectedly high volume of sponsored research, the success of the $225 million Leadership Campaign, and the willingness of M.I.T. people to curtail unnecessary expenses.

But the news could be better, Mr. Currie said. To achieve this year's balance of income and expenses, all items of current income — including unrestricted gifts, grants, and bequests, facilities use fees from research sponsors, and patent revenues — had to be applied against operating costs. In better days much of this undesignated current income would have been added to the Institute's invested funds to earn for the future. And M.I.T. "still faces an excess of demand over resources," Mr. Currie says.

Why Come to M.I.T.? For the Faculty, Says the President

With tuition at $6,200 and a typical student budget at nearly $10,000 for the year, why should undergraduates choose M.I.T.?

President Paul E. Gray's answer to the rhetorical question he asked himself while describing the Institute to the parents of the Class of 1984: Because of "the opportunity to interact one on one with a faculty of considerable distinction."

He was referring, of course, not only to the qualifications of the faculty itself but to the promise implicit in the Undergraduate Research Opportunities Program (UROP) for every student to join faculty research and "make good' on your private visions of grandeur," in the words of Professor Margaret MacVicar, '65, UROP's director.

"Are there financial incentives for excellence in teaching?" asked a parent. And another, apparently remembering some frustrations of his own M.I.T. undergraduate experience, "Are there real limits on research and consulting?" When promotions are considered, Dr. Gray said, "we insist on appraisals of contributions to scholarship, contributions through public service, and quality as a teacher." And it is policy that personal professional work — committees, consulting, and outside enterprises — take no more than 20 percent of any faculty member's time.

But those answers miss the real point, said Dr. Gray. We intend that the line between teaching and research be "fuzzy." "Our most important task as an educational institution is to bring students as early as possible to be independent of formal education — to teach them how to learn." And research is at least as good a way of doing this as anything that happens in a classroom.

The rigor of an M.I.T. education is in one sense very real — and in another sense a little illusory, said Dr. Gray. For students of M.I.T.'s caliber, "adjustment to the idea that there will be a bottom half of the class" is a serious emotional issue. But "the reality is," Dr. Gray assured the parents, "that by January essentially all of the freshman will have come to the conviction that they can not only survive here but thrive in this place." At least 70 percent of the class will graduate in four years or less, and 85 percent will eventually earn M.I.T. degrees.



Kresge Auditorium, the object of concern and then of careful labors for nearly a year after structural deterioration was discovered at its western abutment in September 1979, is open again, a new roof in place. The new covering is a 12-layer sandwich over the original concrete shell: a waterproofing mastic, wooden furring cushioned above and below with Neoprene for sound control, wood boards, Styrofoam insulation, 3/8" plywood, asphalt felt building paper, 1/2" plywood, felt paper, rosin paper, and – the exterior surface – 21,000 square feet of 16-ounce copper sheeting. (Photo: Calvin Campbell)

Housing: A New Dormitory Rises but Time Runs Out for the Class of 1984

Freshman emotional stability is already precarious: new city, new school, new peers, new — and tough — competition. Add fuel to its darker side with "Help! I have no place to live" (due to overcrowded dormitories) and you've experienced the trauma that awaited some new M.I.T. arrivals last fall.

M.I.T. guarantees undergraduate on-campus housing for a full eight terms and requires campus or fraternity housing of freshmen who cannot commute to the campus from their homes. Not all the upperclassmen take the Housing Office up on it — but the current tight, expensive rental housing market in the Boston area has forced many upperclassmen who might otherwise choose to live off campus to claim their right to dormitory space.

The result: a record number of upperclassmen returned to campus housing and joined a large freshmen class to create an all-time high in overcrowding of the M.I.T. dormitories last September.

"A Very Difficult Situation"

Robert A. Sherwood, associate dean for student affairs, whose office copes with housing problems, explains in a letter to *The Tech*: "Returning upperclass residents numbered 48 more seniors, 36 more juniors, and three more sophomores than previously projected, totalling 87 unexpected upperclassmen to be accommodated. Over the past five years, the percentage of juniors returning to the Institute houses as seniors has increased from 78 to 91 percent, and of sophomores returning as juniors from 87 to 93 percent. Only the rate for freshmen returning as sophomores has stayed steady at 95 percent.

Projections based on past years led the Housing Office to expect about 140 overcrowded rooms, but in reality overcrowding exceeded 220.

Mr. Sherwood emphasized that the level of understanding and cooperation among freshmen and their parents was very high. Yet certainly there were adamant protests.

"A very difficult situation, and not a very pleasant one," lamented one parent at a parents' orientation session during R/O week . . . "If I would have known about this beforehand it might have changed my decision to come to M.I.T.," said one disgruntled freshman to *The Tech* . . . Another parent complained that his son's "morale has gone from the high of the freshman picnic to the low of the [temporary housing in] Ashdown basement."

But others were more philosophical. Barbara Chuck, administrative assistant in the Dean's Office, quoted one parent: "It's good that it shows [my son] that things don't always go as expected." (Of the freshmen assigned, 86 percent of the men and women were given rooms in their first-choice house.

By mid-September four options remained to the eight students still in "limbo": turn to the fraternities, where there were a few vacancies despite what everyone agreed was a "successful" rush; live at home (for those with families within commuting distance); take rooms at the Holiday Inn on Massachusetts Avenue near Harvard Square, at the Institute's expense, until campus spaces opened up; or stay in their temporary quarters until vacancies materialized. All eight in limbo decided to stay in small lounges in Ashdown, where a full complement of furniture was moved in for them.

"We Must Recalculate . . .

Under these conditions, it is natural for all eyes to be turned to the West Campus, where the concrete frame for 500 Memorial Drive is now well above the ground east of Westgate. The Institute's newest undergraduate house will add 352 beds — a 15 percent increase — to the undergraduate housing stock by next September.

Originally "next house" — so named to distinguish it from New House completed in 1979 — was expected to solve undergraduate housing problems for several years to come and even to permit increasing the size of the freshman class to 1,100. But it may not work out that way.

"Clearly we need to recalculate our return rate to reflect this year's changes, and we also need to reconsider the projections for next year's freshman class. Our commitment must be to use the new beds in 500 Memorial Drive to reduce the overcrowding to a tolerable level and to accommodate transfer and readmitted students, especially those returning under the new leave-of-absence policy," Dean Sherwood explained in a letter to *The Tech*.

Some other lessons from this year's difficulties: "Many women are unhappy with the unavailability of spaces in single-sex dorms," reported *The Tech*. "The popularity of McCormick Hall (M.I.T.'s only all-female dorm) exceeded its capaciity by a three-to-two ratio, and so over one-third of its applicants had to resort to two single-sex suites in Burton, Bexley and Random Hall," or live in other co-ed residences.

Steven Solnick, '81, editor of *The Tech*, suggested that "M.I.T.'s luck with its unorthodox housing assignment process may be close to running out. Unless all parties involved conduct a careful reassessment of their plans, this year's absurd 11th-hour limbo dance may prove only the beginning of a long, tragic jitterbug . . .

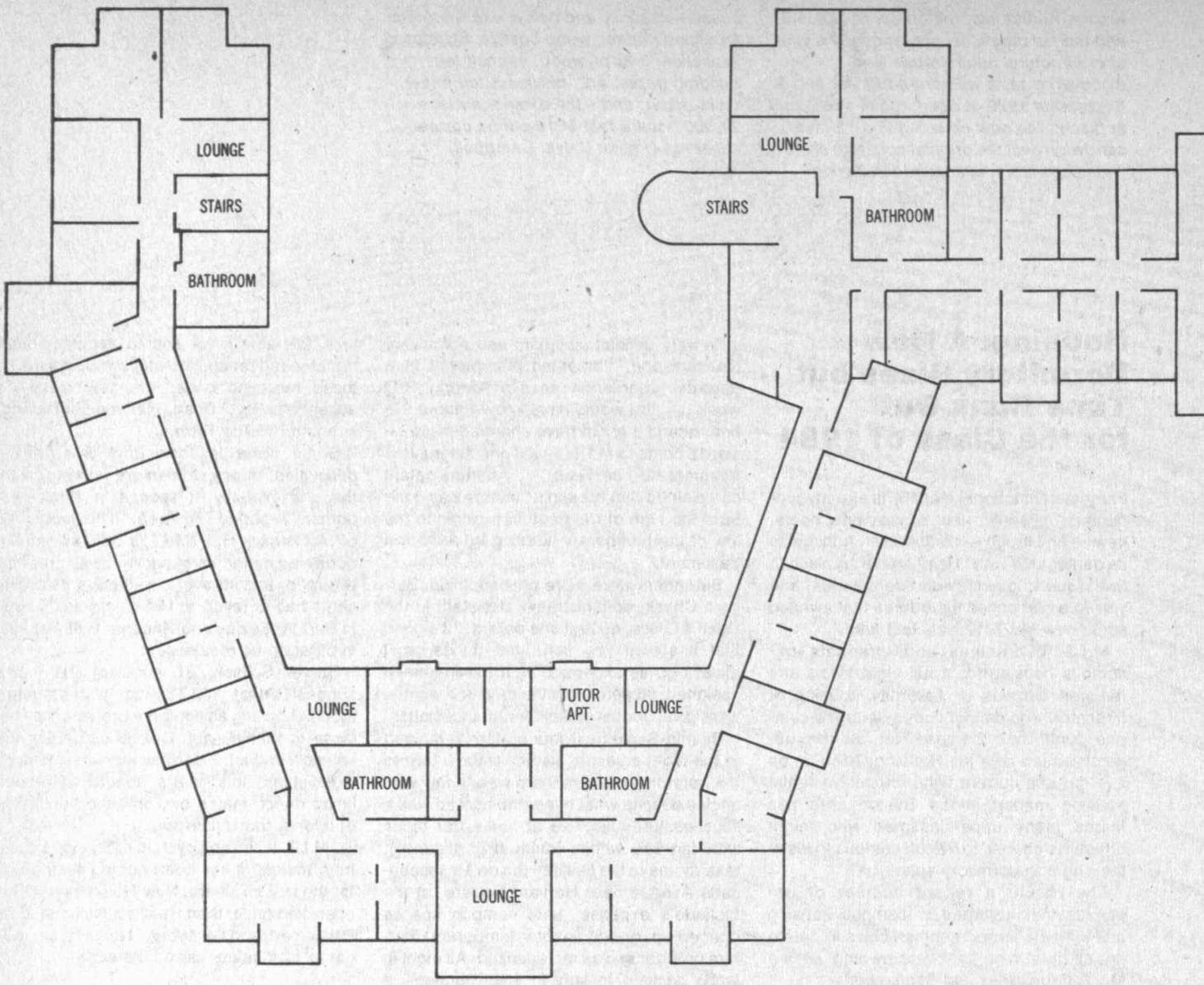
"M.I.T.'s housing system must move back from the cliff it has been edging itself off of for the last six years. New House saved the operation once, then Random Hall and Zeta Psi helped, and next year, "Next House" will get to play safety valve," he adds.

Evolution of a New House

The plan for this "safety valve" to be ready for occupancy in the fall of 1981 evolved from an elaborate process conducted by a Program Planning Group of M.I.T. faculty, staff, and students working with Dober and Associates, Inc., academic planning consultants, in 1979. The idea was to find out as much as possible about what is now seen as most valuable in student living space.

It is necessary to consider, for instance, said the group in its report, "the subtle consequence of transience — the annual turnover in student population and the intraresidence mobility that often occurs as students exercise their choices in housing accommodations." What best encourages congeniality while providing quiet space to study? What, in fact, is a student's room used for?

It is necessary to understand that "variety is not just the spice of life but perhaps the source of life at M.I.T. Rewarding and diverse educational, social and recreational opportunities . . . require accessible and appropriate physical places to be fully



In drawing the plans for "next house" now under construction at 500 Memorial Drive, Sert Jackson and Associates, Inc., architects, were guided by suggestions from a student-faculty-administration planning group working with Dober and Associates, Inc., planning consultants: ". . . single and double rooms, distributed in a random pattern . . . varying dimensions and erratic room configurations to overcome repeating, monotonous cellular designs . . . small lounge spaces for social units, larger floor/entry lounge spaces, house lounge/commons space, and a central dining room/multi-purpose function area . . ." The plan shown is for a typical residential floor of the six-story building.

realized . . .

"Student housing must respond to changing needs and preferences both of the individual and the social groups within the housing." Diversity, variety, flexibility, and adaptability are of extreme importance.

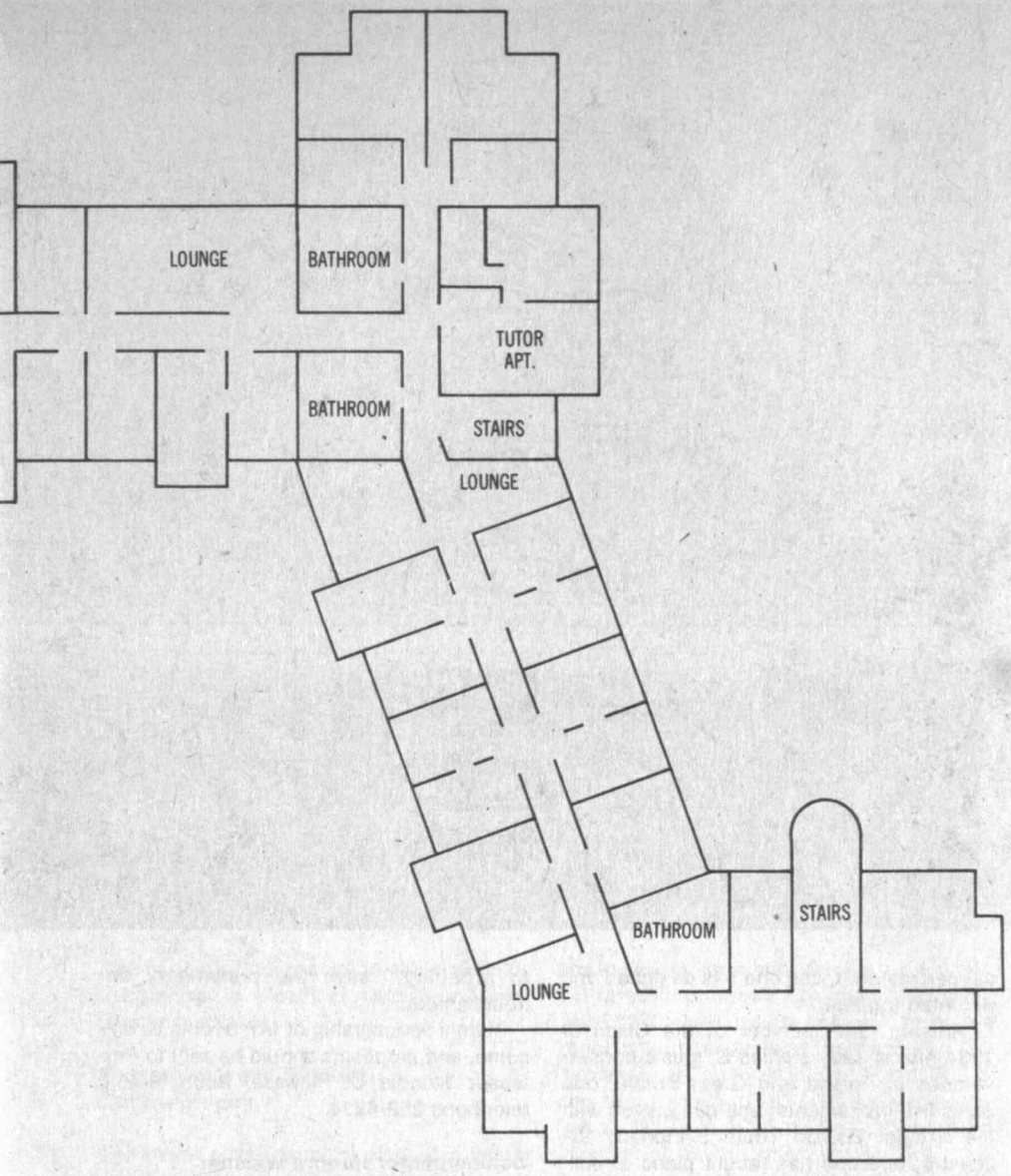
The report emphasizes social interaction: on campus house-dormitory-style housing with single and double rooms was preferable to apartment-style housing partly because it would avoid the potential for early isolation that can occur in very small but self-sufficient living groups. A student's room, said the report, is "a private domain and most personal space." It must have flexibility (with interconnecting room doors), varying dimensions "to overcome repeating, monotonous, cellular designs," adjustable shelving, indestructible walls on which to hang things, vinyl floors, operable sashes, sound-proofing, good locks.

Next House: Nitty Gritty

Suggestions were put into operation, and accordingly Next House (between New House and Tang Hall), will have 21 double and 46 single rooms on each of the four floors above the first floor, with rooms clustered together in groups of eight to 12 students. Each cluster will have a common lounge but no cooking facilities. Most rooms will have a river view, and the rooms that do not will be larger.

The main floor will include a large lounge, which residents must cross to arrive at two centrally located elevators, and a dining hall attached to its northeast corner. Also included: a laundry room, storage room, "country kitchen," after-hours grill, and four activity rooms to be put to use according to the wishes of the student population.

The cost? According to present estimates, about $12.2 million — $35,000 per bed. That's more than the cost of the two new undergraduate houses included in the original goals of the $225 million Leadership Campaign, and 500 Memorial Drive remains a gift opportunity in the Institute's post-campaign program.—*M.L.*



"Incredible Interest" in M.I.T.; a Superfluity of Numbers and of Talent in the New Class of 1984

If numbers prove it, 1980-81 will be a banner year at M.I.T.

As the Class of 1984 settled in, it turned out to include 1,090 freshman — slightly above the 1,050 to 1,075 suggested last year by the Academic Council, thus making a modest contribution to an unprecedented shortage of on-campus housing (*see page A19*) which developed as the term began.

And instead of the 1,100 new graduate students expected by the middle of the summer, as many as 1,300 were counted by the registrar when this issue of the *Review* went to press. For the first time in history, M.I.T.'s graduate enrollment may exceed its undergraduate,.

The freshmen who entered M.I.T. this fall came from 903 different high and preparatory schools in 48 states (only the Dakotas are missing). There are 254 women — the largest number ever in a single M.I.T. class — and 103 minorities; and 69 members of the class are citizens of 26 foreign countries.

More than half the class — 53 percent — is receiving financial aid in some form to attend M.I.T., a total of $3.6 million — $2.1 million in scholarship grants and $1.5 million in loans or employment. The average total loan package is $6,300, the average scholarship $3,700.

A good class, thinks Peter H. Richardson, '42, director of admissions. More than 90 percent were graduated in the top 20 percent of their high school classes; more than 100 were valedictorians. And many have unusual personal achievements:

☐ *Academic*: One freshman is the winner of two national mathematics contests, one speaks four languages, one has won a national spelling bee, one has a published novel and is working on another.

☐ *Entrepreneurial*: One freshman has operated a printing business, another earned money doing magic shows, a third as a disc jockey. Several have worked with handi-

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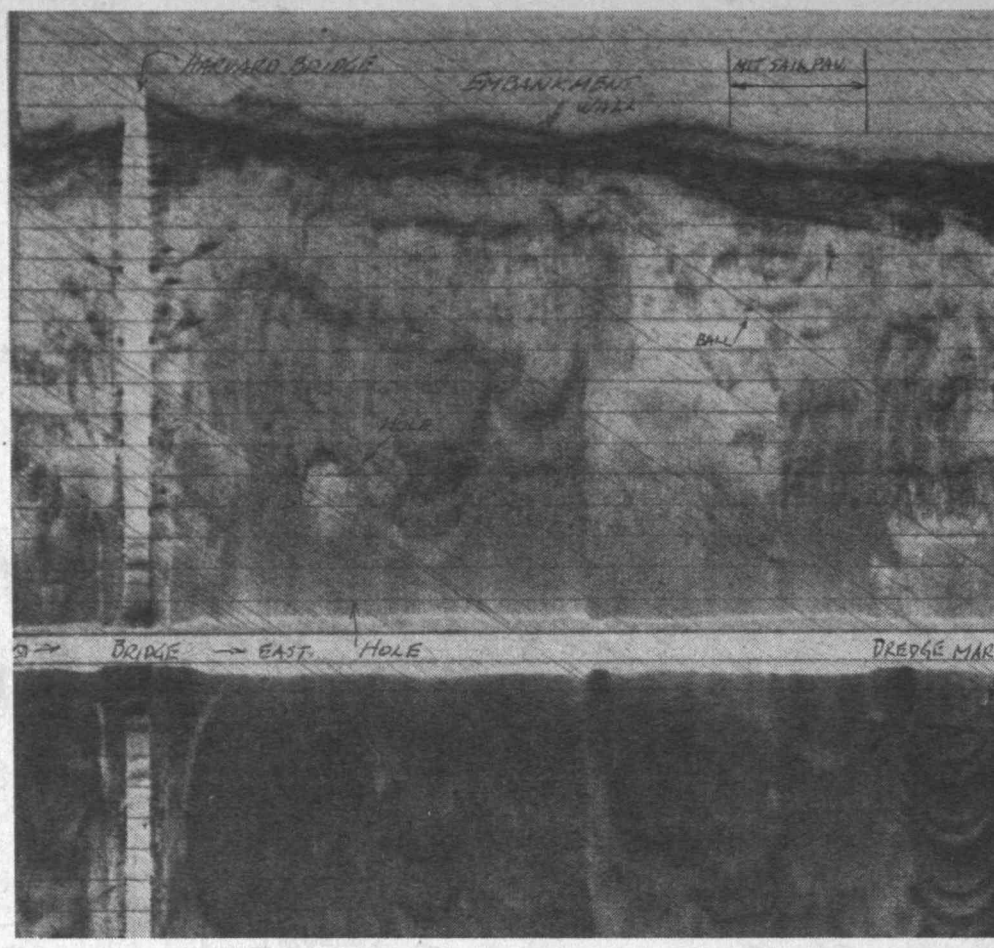
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capped children, and one has designed and patented a game.

☐ *Artistic*: One member of the Class of 1984 has already studied at music conservatories in Poland and Great Britain; one plays five instruments; one has played with the Greater Boston Youth Symphony Orchestra; and one has taught piano at Juilliard.

☐ *Athletic*: One holds six letters in track and field and a black belt in karate; one is a state weightlifting champion, another a National Rifle Association sharpshooter. And one has coached a girls's gynastic team.

The 1,090 new freshmen were selected from 5,678 applicants — the largest total ever — of whom 1,800 were actually granted admission to the Institute. And inquiries about M.I.T. from present high school students are running ahead of a year ago at the same time. The demand for campus tours during the summer "broke all records" — "incredible" interest in the Institute, says Julia C. McLellan, associate director of admissions.

Learning to *Do* Things at IAP

Planning for the 1981 Independent Activities Period — January 5 through 28 — is in full swing. Its emphasis is on "practical" projects, the "manus" side of the Institute's "Mens et Manus" logo, "to reinforce your ability to do things for yourself, from building to repairing," says the preliminary announcement.

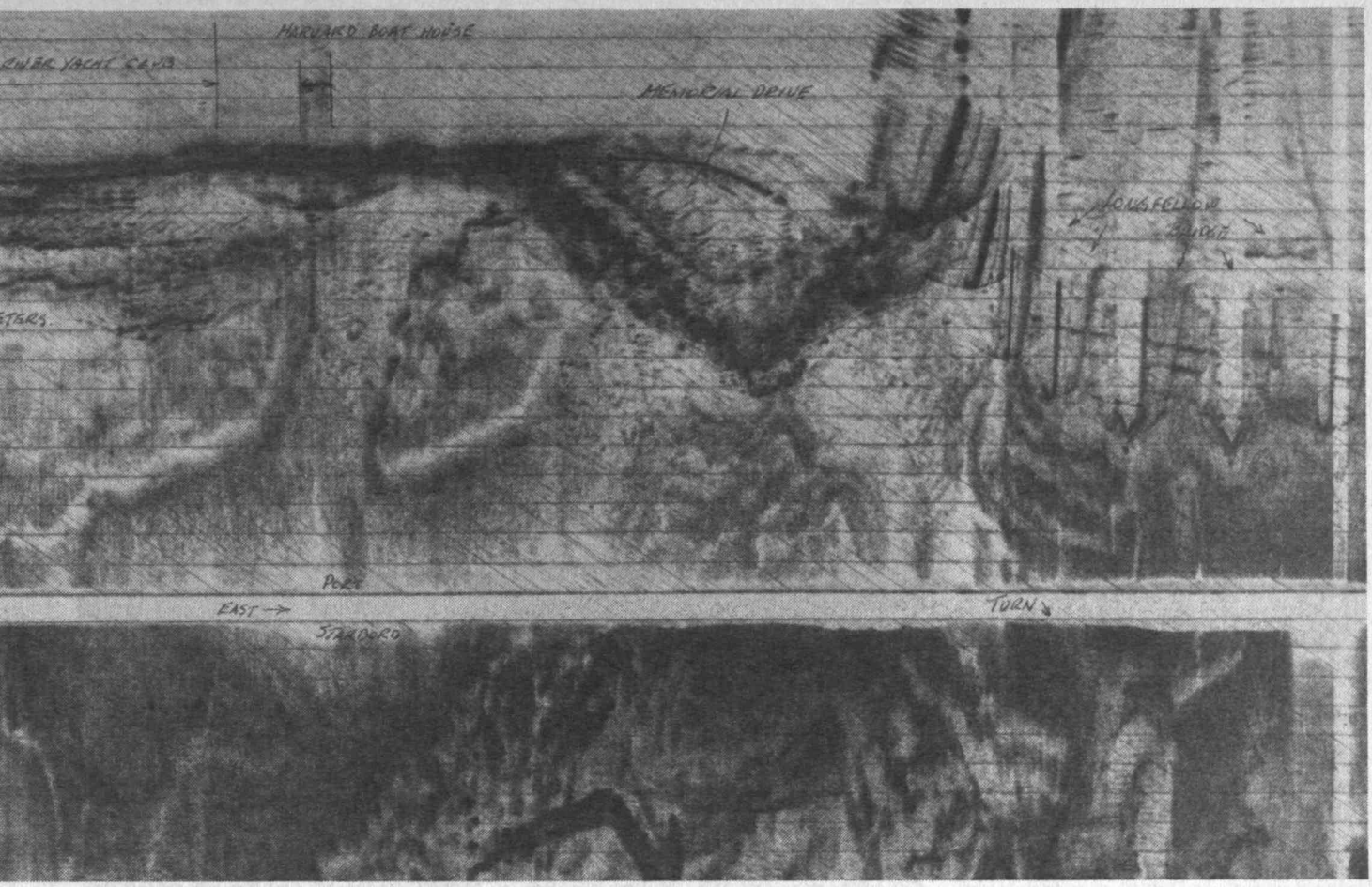
Alumni sponsorship of IAP events is welcome, and proposals should be sent to Professor Woodie C. Flowers, Room 3-453, telephone 253-6234.

Schlumberger Honors Wiesner With a New Professorship

Jerome B. Wiesner, who moved out of the president's office during the last week of June and this fall began his work as Institute Professor in the Program in Science, Technology, and Society, has been honored by a $1 million gift from the Schlumberger Technology Corp. of Houston, a subsidiary of Schlumberger, Ltd.

The gift will fund a Jerome B. Wiesner Professorship, to be available to faculty members throughout the Institute with some emphasis, according to Howard W. Johnson, chairman of the Corporation, on a "strong commitment to state-of-the-art teaching and research." Dr. Wiesner will, in fact, recommend appointees for the chair as long as he is actively associated with the Institute.

It's the second major gift to the Leadership Campaign by the Schlumberger interests; earlier the Schlumberger Foundation completed funding of the Schlumberger Professorship in Earth Sciences, a culmination of the Schlumberger Career Development Fund established in 1976. There has



The Charles River is M.I.T.'s front yard, but who among us knows what's there? Professor Harold E. Edgerton, Sc.D.'31, for one, who cruised his side-scan sonar down the river 150 meters south of the Cambridge shore one day last spring. Here's the picture — the river-bottom from the Harvard Bridge (left) past the Sailing Pavilion, the Charles River Yacht Club, and the Harvard sailboat house to the Longfellow Bridge.

also been continuing support since 1955 for fellowships in electrical engineering and computer science.

Meteorology and Physical Oceanography

The major interactions of air and water in weather, climate, and the world ocean — and the similarities of the equations that govern air and water — are now recognized by a new name: it's become the Department of Meteorology and Physical Oceanography at M.I.T.

Oceanography has been a regular subject in its curriculum for 51 of the department's 52 years. And so it can be argued, said Professor Edward N. Lorenz, head of the department, in his presentation to the faculty, that the change actually comes 50 years too late.

Two physical oceanographers now on the faculty of the Department of Earth and Planetary Sciences — Professors Carl I. Wunsch, '62, and Charles C. Eriksen — now have joint appointments in the two departments.

Seamans to Retire as Dean

Robert C. Seamans, Sc.D.'51, has announced his intention to retire as dean of engineering at M.I.T. at the end of the current academic year, and Francis E. Low, provost of the Institute, is forming a committee to search for a successor.

Professor Seamans has been dean since July 1978; he'll return next fall to active teaching and research as the Henry R. Luce Professor of Environment and Public Policy, the post he held in 1977-78. Before returning to M.I.T. in 1977 he had completed a number of major public assignments: associate and deputy administrator of NASA (1960-68), Secretary of the Air Force (1973-74) and administrator of the Energy Research and Development Administration (1974-77).

Planning a February Florida Festival

Irwin W. Sizer, former dean of the Graduate School who is now president of the Whitaker Health Sciences Fund; Norman C. Rasmussen, Ph.D.'56, head of the Department of Nuclear Engineering; and President Paul E. Gray, '54, will be featured speakers at the 1981 Florida Festival set for February 21 at Cypress Gardens.

In addition to the afternoon-and-evening program on Saturday, Sunday, February 22, will be a special "on-your-own" day at Cypress Gardens for the several hundred alumni and their families who are expected. For further information: George H. Wayne, '48 (4280 Galt Ocean Drive, Fort Lauderdale, FL 33308) or Carol D. Seligson, '71, the Alumni Association's regional director for the Southeast, at Room 10-123, M.I.T.

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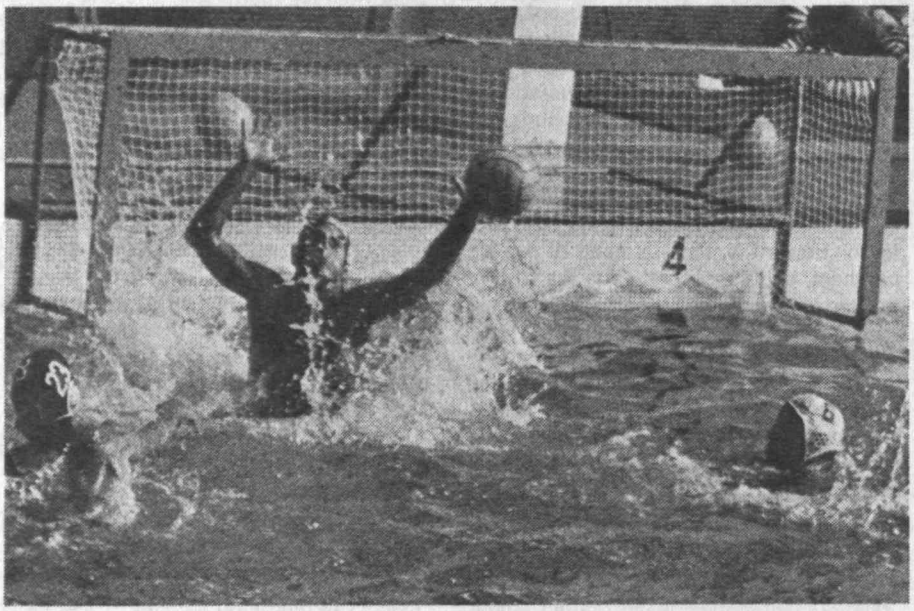
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When he commissioned Holger Danske *of Danish designer K. Aage Nielson (center), John J. Wilson, '29 (left) wanted a comfortable boat for cruising. He has that, and more: a winner of the 1980 Newport-to-Bermuda race, sailed by a crew led by Mr. Wilson's son, Richard, S.M.'76 (right). Built in 1974,* Holger Danske *is a 42-foot double-ended ketch. With John Wilson as skipper, she's made a number of trans-Atlantic crossings; and she attempted the Newport-Bermuda race in 1970 only to be becalmed for 44 hours. This year there was no such problem; the crew of ten sailed 650 miles to cover the 635-mile distance and win the model of St. David's Light, Bermuda, which serves as winner's trophy.*



This time it didn't work, as the Harvard goalie deflected a shot by M.I.T.'s John Belzer. But in the end it was M.I.T. 12, Harvard 10 in the water polo season opener late in September. (Photo: Allan J. O'Connor from The Tech*)*

Courses



J.M. Sussman

I
Civil Engineering

Three alumni of the department were instructors in continuing education courses offered during the 1980 annual convention of the American Society of Civil Engineers: Professor Robert H. Scanlan, Ph.D.'43, of Princeton on wind effects on buildings; Professor Noel D. Nathan, S.M.'54, of the University of British Columbia on finite element analysis; and Mark W. Tenney, '58, president of TenEch Environmental Consultants, Inc., South Bend, Ind., on operating a consulting firm.

Stanley M. White, S.M.'76, is currently employed by Han-Padron Associates, New York, N.Y.; a small consulting firm specializing in coastal engineering — ports, harbors, breakwaters, sea islands, and single point moorings. . . . **Robert C. Kirby,** S.M.'72, assistant project engineer, Woodward-Clyde Consultants, Clifton, N.J., has been named a 1980 recipient of the C.A. Hogentogler Award by the American Society for Testing and Materials, for his paper, "Soil Capacity for Supporting Deep Foundation Members in Clay."

III
Materials Science and Engineering

Morris Cohen, Sc.D.'33, institute professor, emeritus, and professor of the department, emeritus, has been honored as the first occidental to be named as honorary professor of Beijing University of Iron and Steel Technology. . . . **John R. Hutchins III,** Sc.D.'59, has been nominated for election as a senior vice president of Corning Glass Works, Corning, N.Y. . . . **Michael Karl Korenko,** Sc.D.'73, materials research manager of Westinghouse-Hanford Engineering Development Laboratory, Richland, Wash., has been appointed a White House Fellow to perform government service for the 1980-1981 year. . . . **Frank E. Woolley,** Sc.D.'66, has been appointed to the technical staff division of Corning Glass Works, Corning, N.Y.

Karl L. Fetters writes from Poland, Ohio, that he has been retired for two years and now enjoys travelling with his wife, Virginia. They recently went to Quito, Ecuador, and the Galapagos Islands, then flew over the Andes to Coca on the Napa River in the Amazon area. Virginia makes excellent movies and adds sound tracks; then they show the films to "old people" and school children.

IV
Architecture

CM, Inc., Constructors/Managers, Houston, Tex., has recently announced two new appointments to their firm; **Francis G. Whitcomb,** M.Arch.'64, as chairman and chief executive officer, and **Robert P. Cooke,** M.Arch.'62, as senior vice president.

VI
Electrical Engineering and Computer Science

To Professor Mildred Dresselhaus, director of the Center for Materials Science and Engineering, an honorary doctor of science from Smith College: "By setting rigorous standards yourself in every area of performance, you have in your own career perfected a model for others to emulate."

Harold E. Edgerton, Sc.D.'27, institute professor emeritus, was busily engaged in several underwater expeditions this past summer, one of which was in Charleston, S.C., searching for the remains of a Civil War submarine. He also worked with a Canadian group seeking historical artifacts along a 45-mile stretch of the Richelieu River between Lake Champlain and the St. Lawrence River. Following this adventure, he traveled to Scotland to collaborate with an archeologist in quest of barges and the first stream dredges employed in building the network of canals in the British Isles.

Elias P. Gyftopoulos, Sc.D.'58, Ford Professor in the department has been elected director of New England Nuclear Corp., Boston, Mass., a maker of radioactive chemicals. . . . **Alexander Kusko,** Sc.D.'44, lecturer in the department, has been named recipient of the 1980 William E. Newell Power Electronics Award from the Institute of Electrical and Electronics Engineers. . . . **Clarence J. Baldwin,** '57, has been named manager of advanced systems technology of Westinghouse Electric Corp., Pittsburgh, Penn.

Ivan E. Sutherland, Ph.D.'63, a professor of computer science at the California Institute of Technology, was named director of Quontron Systems, Inc., Los Angeles, Calif.; a financial information systems supplier. . . . **Robert H. Eisengrein,** S.M.'49, reports that he is still employed with Kingsbury Machine Tool Co., as a marketing and system engineer and is also in the state legislature of New Hampshire. . . . **Leonard Kleinrock,** Ph.D.'59, professor of computer science in the UCLA School of Engineering and Applied Science, has been elected to the National Academy of Engineering, for his pioneering research in computer communications networks.

Edward E. David, Jr., Sc.D.'47, president of

Sussman Heads Civil Engineering

Professor Joseph M. Sussman, Ph.D.'67, who has been associated with its Transportation Division since before becoming a member of the faculty in the Department of Civil Engineering, is now head of that department; he succeeds Professor Frank E. Perkins, '55, now associate provost of the Institute.

In addition to his faculty post in civil engineering, Professor Sussman was associate dean for educational programs in the School of Engineering from 1977 to 1979, where he had a major role in creating a new program of off-campus work experience for engineering students. His professional work in modelling rail freight systems is widely recognized in the U.S. railroad industry, and Professor Sussman is in fact M.I.T.'s leading railroad expert. He joined the civil engineering faculty upon completing his doctorate; his earlier degrees are from City College of New York (B.C.E. 1961) and the University of New Hampshire (M.S. 1963).

Can They Clean Ohio Coal?

A new dry process for removing sulfur from pulverized coal is now being promoted by John F. O'Donnell, Sc.D.'55, and his colleagues at Advanced Engineering Dynamics in Natick, Mass., and the Ohio Department of Energy has contracted with AED for testing the process on Ohio coals.

Robert S. Ryan, Ohio energy director, is enthusiastic; he talks of "significant capital savings in construction and operating cost" in a system for sulfur and ash removal "which will allow the burning of Ohio coal in an environmentally acceptable manner."

The AED process is proprietary; Dr. O'Donnell, who is president of AED, explains that it "uses advanced principles of ionization and electrostatic separation" — the first time anyone has been able to remove "significant amounts of sulfur" from coal by a dry process, without chemicals, he says.

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Exxon Research and Engineering Co., will deliver the Keynote Address at the 1980 American Association of Engineering Societies Conference. The speech will address engineering and its impact on this decade. . . . **Henry Cox,** Sc.D.'63, has been named by the American Society of Naval Engineers to receive its Gold Metal Award for his outstanding leadership and contributions to the field of underseas surveillance. . . . **Peter J. Denning,** Ph.D.'68, has been elected president of the Association for Computing Machinery for a two-year term, and remarked, "I am excited to be president of ACM during such a propitious period." He has been on the staff of ACM since 1968 and is also head of the computer science department at Purdue University, the oldest department of computer science in the U.S.



Peter J. Denning

David M. Perozek, S.M.'67, has been named general manager of Hewlett-Packard's Andover, Massachusetts division. . . . **Robert Schissler,** Sc.D.'55, recently joined the systems components division of Analog Devices' Instruments and Systems Group, as senior staff engineer. . . . **Douglas T. Ross,** S.M.'54, chairman of Softech, Waltham, Mass., has been awarded the 1980 Distinguished Contributions Award by the Society of Manufacturing Engineers at its annual meeting. The citation read; "Educator, research scientist, and successful entrepreneur in the field of software engineering . . ."

James M. Thurston, Sc.D.'43, has retired as head of the electrical and computer engineering department at Clemson University, Clemson, S.C., after 27 years of service. . . . **John I. Makhoul,** Ph.D.'70, has been elected principal scientist at Bolt, Beranek and Newman, Inc., the firms highest technical rank.

VI-A

Cooperative Course in Electrical Engineering and Computer Science

The largest number of VI-As ever were out on work assignment this past summer — a total of 277 students. They also represented the widest-ever geographical distribution of company assignments throughout the United States: east to west, from Boston, Mass., to San Francisco, Calif.; north to south, from Burlington, Vt., to Minneapolis, Minn., Vancouver, Wash., to Dallas/Houston, Tex., Phoenix, Ariz.; and places in between. All were visited by one of the 30 VI-A faculty advisors now involved with the VI-A program. Quite a change from the early days of VI-A when everything was kept within a day's train ride of M.I.T.!

The fall found a record number of VI-As applying for admission to graduate school under the five-year S.B./S.M. aspects of the program — 88 to be exact. Fifty-four of these seniors have been granted intitial S.M.-degree-only admission for the coming year. A few more will be admitted come February after a review of fall-term grades.

Currently, 21.5 percent of the department's undergraduates are enrolled in the VI-A program. Of the total undergraduate and graduate students, 18.6 percent are now participants in VI-A — the highest number in VI-A's 63-year history! With a marked increase in the sophomore enrollment this fall, the pressure for an even larger program looms large for the next spring's selection process.

Director Tucker was again a guest at the annual TI VI-A luncheon hosted by **Cecil H. Green,** '23 at the Petroleum Club in Dallas on August 13. All TI VI-A students and their managers were present, along with Group Vice-President **Joseph Zimmerman,** '59, and **Dean R. Collins,** '58 of TI's Central Research Laboratory. Newly employed by TI is VI-A graduate, **Steven D. Krueger,** '79, who also attended.

Continuing his trip to the West Coast, Director Tucker visited students and management at Fairchild, Hewlett-Packard, and Xerox. He also hosted the second annual Bay Area VI-A picnic, which 22 of this year's 31 West Coast VI-A students attended. It was held in Braly Park, Mountain View, Calif.

Again held during Director Tucker's Palo Alto visit was the traditional home-cooked Chinese dinner by VI-A alumni of Hewlett-Packard Laboratories. Attending, at the home of **Allen J. Baum,** '74 were: **Alan M. Marcum,** '78, **Lynn M. Roylance Freret,** '72, and her husband **Payne Freret,** '68, **Steven M. Weiss,** '81, and **Kenneth A. VanBree,** '71.

While in the Bay Area, Mr. Tucker visited the home of **William R. Bidermann,** '76, in Mountain View and saw his new son, Steven M., born July 18. He also visited with **John F. Cooper,** '74, who is now a production manager in Hewlett-Packard's Microwave Division, Palo Alto, Calif.

Hosting a luncheon during Director Tucker's visit to the Hewlett-Packard Laboratories was **Dr. Paul E. Stoft,** '49, now director of the Lab's Electronics Research Center. Alumni attending were **Kenneth A. VanBree,** '71, and **Laurence G. Walker,** '73. While visiting the General Systems Division, Cupertino, Calif., Mr. Tucker ran into

Gordon Innovation Professors

It was six years ago that Bernard M. Gordon, '48, chairman and technical director of Analogic Corp. established a Gordon Faculty Fund to help stress proficiency, creativity, and product development in the training of electrical engineers. Now that fund has led to two Gordon Professorships in Engineering Innovation and Practice in the department and two appointments as Gordon Professors:

☐ William F. Schreiber, professor of electrical engineering whose work is in the field of image processing, visual perception, and the use of laser scanners for graphic arts and medical applications.

☐ Stanley S. Rich, executive vice president and technical director of O'Donnell and Rich, Inc., who has become adjunct professor in the department. Mr. Rich's career in ultrasonics, electrostatics, and electromechanical systems and components has emphasized the development of new enterprises and new products.

Mr. Gordon himself has a distinguished record in successful innovation and product design; he's been associated with the M.I.T. Innovation Center and is a frequent lecturer in the Department of Electrical Engineering and Computer Science.

Mark S. Linsky, '72. Mark is now the proud father of a baby girl.

During his visit to Xerox PARC, Mr. Tucker met **D. Austin Henderson, Jr.,** '75, and **Michael D. Schroeder,** '73.

It is with great sadness that we note the death of **Professor William K. Linvill,** '45. Mr. Tucker visited Bill on several occasions at his Stanford University office, where he was head of the Department of Engineering Economic Systems, which he founded.

This fall finds two faculty appointed Bernard M. Gordon ('48) Professors in the department. The chairs were established by an endowment from Mr. Gordon, for instruction in engineering innovation and practice in the department. Mr. Gordon is presently chairman and technical director of Analogic Corp., Wakefield, Mass.

Another highly successful VI-A graduate, **Joseph F. Keithley,** '37, chairman of Keithley Instruments, Inc., Cleveland, Ohio, presented incoming **President Paul E. Gray,** '54, with the start of an endowment fund in support of a professorship in career development to be named for Mr. Keithley.

On the department's teaching staff as a lecturer this fall is **Robert H. Kingston,** '47, of M.I.T.'s Lincoln Laboratory staff, also a VI-A graduate. He is teaching a special subject, 6.974, entitled "Detection of Optical and Infrared Radiation." His office, coincidentally, is in the VI-A suite, Room 38-473.

During other VI-A visits this summer, Mr. Tucker met **Martin P. Lurie,** '78, who is with IBM, Burlington, Mass.; and **Jonathan R. Leehey,** '78, who is with C.S. Draper Laboratory, Cambridge, Mass.

A co-winner of the prestigious IEEE 1980 Emanuel R. Piore Award is **Lawrence R. Rabiner,** '64, of Bell Laboratories. Dr. Rabiner has supervised a number of master's theses of VI-A Bell Labs students.

Professor Emeritus Karl L. Wildes, '22, associated for many years with the VI-A Program under Professor William Timbie, recently had a visit from VI-A graduate **Paul G. Herkart,** '34, and his wife. Mr. Tucker was invited to join them for lunch and a pleasant time was had reminiscing about VI-A. Mr. Herkart is with RCA's Sarnoff Laboratories, Princeton, N.J.

Finally, we note others who have visited the VI-A Office since our last article: **Allen J. Baum,** '74; in Boston for the meeting of science fiction writers; **Michael Paluszek,** '76, who is now with Draper Laboratories; and **Kelly M. Pan,** '78, who has been with Digital Equipment Corp. but is attending Harvard Business School this fall.— John A. Tucker, Director, Course VI-A, Room 38-473, M.I.T., Cambridge, MA 02139

VII
Biology

Barbara R. Baumstack, Ph.D.'76, is currently assistant professor of biochemistry at Emory Medical School, Atlanta, Ga. . . . **Walter C. Vinson, Jr.,** Ph.D.'72, of Chicago, Ill., died on February 2, 1980.

X
Chemical Engineering

Richard de Filippi, Sc.D.'59, has been named president and chief executive officer of Critical Fluid Systems, Inc., a new subsidiary of Arthur D. Little, Inc., temporarily located in Acorn Park, Mass. . . . **David J. Mawer,** S.M.'62, reports that he is presently vice president of process with DMI International, Houston, Tex. DMI is a company formed following the merger of Davy Corp. and McKee. . . . **Gouq-Jen Su,** Sc.D.'37, professor emeritus of chemical engineering at the University of Rochester, N.Y., has been selected a Fellow of the American Institute of Chemical Engineers, one of the highest honors that can be conferred on a chemical engineer. . . . **A. David Rossin,** S.M.'55, a system nuclear research engineer for the Commonwealth Edison Co., Chicago, Ill., has published an article "The Soft Energy Path: Where Does It Really Lead?" in the *The Futurist*, June 1980. The article's focus is that "the soft energy path, contrary to the claims of its proponents, could lead to energy rationing, slower economic growth, and ultimately, even more centralization and larger government bureaucracies."

Roger W.M. Letts, Sc.D.'56, has been named director of distribution of Engelhard's Corp. Minerals and Chemicals Division, Edison, N.J., responsible for providing logistics support in the areas of customer service, planning and scheduling, general traffic and export administration to each of the division's business units. . . . **Wayne H. Pitcher,** Sc.D.'72, has been appointed to the technical staff division of Corning Glass Works, Corning, N.Y. . . . **Michael Jon Kell,** S.M.'72, has returned to school to obtain his M.D.-Ph.D. from Emory University.



Roger W.M. Letts

XIII
Ocean Engineering

Kiyoshi Ando, S.M.'78, is currently a research engineer, Ship Strength Research Laboratory, Nagasaki Technical Institute, Mitsubishi Heavy Industries, Ltd., Nagasaki, Japan. . . . **Louis K. Bragaw, Jr.,** S.M.'64, retired as a captain in the Coast Guard in January 1980, and was appointed professor of management at the Hartford Graduate Centre, Rensselaer Polytechnic Institute. He served as president of the Eastern Academy of Management this past year and has published a book, *Managing A Federal Agency: The Hidden Stimulus*, published by the Johns Hopkins University Press. . . . **R. "Morgan" Watt, Jr.,** S.M.'23, was honored with the presentation of an American flag in the Flag Day ceremony held at the Fryeburg Health Care Center, in recognition of his naval career which spanned 50 years. He had served at virtually every naval shipbuilding facility in the country and retired ten years ago, as a rear admiral.

XIV
Economics

Jagdish N. Bhagwati, Ph.D.'57, Ford International Professor in the deparment has been chosen by the John Simon Guggenheim Memorial Foundation as a Guggenheim Fellow for 1980. The fellowship is awarded "on the basis of demonstrated accomplishment in the past and strong promise for the future." . . . **Stephen M. Goldfeld,** Ph.D.'63, has been named one of the three members of the President's Council of Economic Advisors, filling the prestigious position of chief forecaster.

Halbert L. White, Jr., Ph.D.'76, has joined the

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P.H. Smith

A Latin American Expert Heads the Humanities

Peter H. Smith, professor of history at the University of Wisconsin since 1972 and associate dean of its Graduate School since 1978, came to M.I.T. in September to be head of the Department of Humanities, associate dean for humanities programs of the School of Humanities and Social Science, and professor of history. It's a major appointment, and Professor Smith has appropriate credentials as a major scholar in Latin American history and political development.

Professor Smith studied at Harvard (B.A. 1961) and Columbia (M.A. 1963, Ph.D. 1966), and he holds additional certificates from Columbia as a graduate of its International Fellows Program and Institute of Latin American Studies. He joined the University of Wisconsin in 1968 and for three years from 1976 to 1979 was head of its History Department. In addition, he has been a visiting scholar at El Colegio de Mexico and at the Institute for Advanced Study at Princeton, and he is vice-president and president-elect of the Latin American Studies Association. He is the author of three books on Latin American politics and of countless articles in scholarly journals and other books.

Department of Economics at the University of California at San Diego and has established HLW Consulting, an econometric forecasting firm specializing in gold prices. Late last summer he told Donald C. Bauder, financial editor of the *San Diego Union*, that gold prices might start an upward spiral early in 1981, with prices reaching $1,200 an ounce by July.

XV
Management

George W. Shuster, S.M.'69, has been named vice president and general counsel of the Cranston Print Works Co., Cranston, R.I. . . . **Robert E. Smylie,** S.M.'67, deputy director of NASA's Goddard Space Flight Center, Greenbelt, Md., has been named associate administrator for Space Tracking and Data Systems at NASA headquarters. . . . **Thomas A. Helmrath,** S.M.'77, is currently vice chancellor, Health Affairs, of the Ohio Board of regents, responsible for planning and coordinating Ohio's statewide system of health education programs. . . . **Robert E. Wall,** S.M.'72, has been appointed controller of Browning Ferris Industries, Houston, Tex.

Perry D. Cohen, Ph.D.'71, reports, "had a daughter, Shayna Katherine in September 1979; have established a management consulting practice specializing in areas of organizational development, human resources planning, evaluation research, and health delivery systems; and have completed my Ph.D. in organizational studies and management." . . . **William F. Gerken,** S.M.'58, passed away on March 14, 1980.

Thomas E. Schroeder, S.M.'72, has been named manager of service, distribution, profit planning and analysis for Xerox Corp.'s Information Systems Group, Rochester, N.Y. . . . **Mayer Wantman,** S.M.'66, reports that he and his wife, Linda, have enjoyed living in England since 1973. He has four children, Adam (11), Elizabeth (9), Simon (5), and Paula (1). He is currently a consultant, specializing in computer program design. . . .

XVI
Aeronautics and Astronautics

Yao Tzu Li, Sc.D.'38, professor emeritus and senior lecturer and **David G. Jansson,** Sc.D.'68, both of the department, have co-authored a book, *Technological Innovation in Education and Industry*, published by Van Nostrand Reinhold. This landmark volume offers the first definitive treatment ever of parameter analysis.

John W. King III, S.M.'16, passed away on June 12, 1980. Among his many naval and aviation accomplishments, he served as ship's officer and later squadron commander aboard the USS Saratoga; during World War II, he was called upon to establish two new aviation commands for flight delivery by Naval Reserve pilots of new aircraft throughout the continental U.S.; and in 1953, he joined Stroukoff Aircraft, West Trenton, N.J. . . . **Robert M. Edwards,** S.M.'68, was awarded the 21st Burka Award for a computational technique used for evaluating mathematical models of the earth's gravity field, by the United States Air Force, Wright-Patterson Air Force Base, Ohio.

Charles J. Bartlett, Ph.D.'66, has been named head of the Interconnection Systems Studies Department of Bell Laboratories, Whippany, N.J. . . . **Robert L. Wildey,** S.M.'61, has been named vice president of marketing at Gates Learjet Corp., Wichita, Ks. . . . **Katherine Busboom Magrath,** S.M.'76, has been appointed director of equity investments of the Ford Foundation, New York, N.Y. . . . **Joseph Mallen,** S.M.'48, has been promoted from vice president of operations, to president of Boeing Vertol Co., Philadelphia, Penn. . . . **Earle L. Messere,** S.M.'64, has been named as deputy technical director of the Naval Underwater Systems Center, Newport, R.I. . . . **High E. Witt,** S.M.'57, has been elected vice president-government liaison of United Technologies Corp., Washington, D.C.; responsible for maintaining liaison with all branches of the federal government. . . . **Richard V. Warden,** S.M.'59, president of Raytheon Marine Co., has been appointed to the executive board of the New Hampshire Oceanographic Foundation.

Professorship Honoring Penney as a Legend in Retailing

A $1 million gift from Mrs. Caroline A. Penney of New York City has made possible the J.C. Penney Professorship in Management; and Robert C. Merton, Ph.D.'70, formerly professor of finance in the Sloan School of Management, has been named to the new chair.

The gift from Mrs. Penney honors her late husband, who — as founder of the J.C. Penney Department Store chain — was a legend in the retail trade industry. His first store was opened in 1902; by 1970, a year before Mr. Penney's death at the age of 96, the company embraced some 1,700 stores throughout the U.S.

Professor Merton has been a member of the M.I.T. faculty specializing in financial models of consumers and institutions since receiving his degree in the Department of Economics. His earlier degrees were in engineering mathematics (B.S. Columbia 1966) and applied mathematics (M.S. California Institute of Technology 1967).

XVIII
Mathematics

R. Wells Johnson, Ph.D.'61, has been appointed chairman of the Department of Mathematics for a three-year term commencing in January 1981, at Bowdoin College, Brunswick, Me. . . . **William Platte,** Ph.D.'71, has announced his candidacy as a Republican for state representative in the Massachusetts District 92, November 4 election. . . . **Cathleen Morawetz,** S.M.'46, professor of mathematics at the Courant Institute of Mathematical Sciences at New York University has been elected to the Board of Trustees of the Alfred P. Sloan Foundation. . . . **John F. Magee,** '51, president and chief executive officer of Arthur D. Little, Inc., has been elected to the Board of Trustees of Woods Hole Oceanographic Institution, Woods Hole, Mass.

XIX
Meteorology

Eugene M. Thomas, S.M.'39, of El Paso, Tex., died on April 4, 1980. . . . **Robert M. White,** S.M.'19, president of the University Corp. for Atmospheric Research, Boulder, Co., has been named to chair the Commission on Natural Resources for a three-year term beginning in October, 1983. The National Research Council is the operating arm of the National Academy of Sciences and the National Academy of Engineering. . . . **Frederick G. Shuman,** Sc.D.'48, has been awarded the Second Half Century Award by the American Meterological Society, the society's

Closer Ties With Boeing

A $500,000 gift from the Boeing Co. has established the Boeing Career Development Professorship in the Department of Aeronautics and Astronautics, and two young members of the department have been designated as first beneficiaries of its funds to develop their teaching and research activities:

☐ **Edward F. Crawley,** '76, who joined the faculty last fall, will extend the research reported in his Ph.D. thesis on turbomachine blade flutter boundaries.

☐ **Antonio L. Elias,** '72, will work in the field of flight transportation. He joined the faculty a year ago, having previously been with the Charles Stark Draper Laboratory's space shuttle program.

Thornton A. Wilson, S.M.'53, chairman and chief executive officer of Boeing, says the new professorship will "strengthen a unique and beneficial relationship between Boeing and M.I.T. that has existed since the earliest days of aviation." Mr. Wilson is one of 22 Boeing executives who are graduates of the M.I.T. Sloan Fellows Program, and 17 others have attended the Program for Senior Executives in the Sloan School of Management.

second highest honor. . . . **David L. Tweedy,** S.M.'65, is presently a consultant and manager of treasury services for the planning services division of Management Decision Systems, Inc., Waltham, Mass.

XXII

Nuclear Engineering

George T. Hamilton, S.M.'69, has been appointed vice president of business development for Nuclear Energy Services, Inc., Danbury, Conn. . . . **Nancy Timmerman,** S.M.'74, an engineer at Bolt, Beranek, and Newman, Inc., has become the first woman to be admitted to full membership in the Institute of Noise Control Engineering. . . . **K. Keith Roe,** S.M.'74, has been named a vice president and officer at Burns and Roe, Inc., Oradell, N.J. . . . **Franklin R. Chang,** Ph.D.'77, has been chosen as an astronaut candidate by NASA. He is presently engaged in a training program at the Johnson Space Center, after which he expects to be assigned to a project associated with the space shuttle.



K. Keith Roe

No Measure for Innovations

Given that so many of us agree on the crucial role of innovation as a wellspring of prosperity and industrial growth, how curious that there are no units for measuring it and indeed no standards for innovativeness.

The problem, writes Kenneth G. McKay, Ph.D.'41, who retired early this year after a 34-year career with AT&T, lies in the nature of innovation itself. It's a broad, abstract idea, covering everything from a creative concept to a new product to a new market for an old idea . . .

A subject so diverse can be "surrounded and various facets examined," writes Dr. McKay in *Bell Laboratories Record* (July/August, 1980), "but the total measure has defied quantification."

So, like many others, Dr. McKay resorts to analyzing inputs and outputs. In the case of Bell Laboratories, he knows these well: at the time of his retirement Dr. McKay was the Laboratories' executive vice president, and his first Bell System assignment in 1946 was to Bell Labs' work on electron emission, semiconductors, and insulators.

The input: a technical staff of 9,000 supported by a $1 billion budget (1979).

Among the outputs:

☐ Some 60 major awards to members of the staff in 1978; four Nobel Prizes since 1925.

☐ A total of 4,942 technical talks and publications by members of the staff in 1978.

☐ An average of 300 patents per year since 1975 and a total of 19,000 since Bell Labs' founding in 1925. (But patent statistics can paint a "misleading picture" of innovation, Dr. McKay warns. Lots of significant innovations never are patented, including both software and integrated circuits, which the courts rule are unpatentable.)

☐ By its own count, a total of 683 Bell System innovations whose genesis was in Bell Labs between 1925 and 1977.

Technology and Policy Program

Professor Richard de Neufville, chairman of Technology and Policy Program, recently travelled to the People's Republic of China under the auspices of a White House Fellowship to observe industrial development in Manchuria.

Two recent graduates have entered law school:

☐ **Bobby Gillenwater,** S.M.'80 — Boston College Law School; and

☐ **Steven Foss,** S.M.'80 — University of Michigan Law School

Patricia Foley, S.M.'79, has returned to M.I.T. from a one-year internship in Washington, D.C. She is the recipient of the Hugh Hampton Young Memorial Fellowship for the coming year, which will be used toward the continuation of her studies.— Professor Richard de Neufville, Chairman, Technology and Policy Program, Room 1-138, M.I.T., Cambridge, MA 02139

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Puzzle Corner
Allan J. Gottlieb

Taxes: Five People, Five Calculators



Allan Gottlieb is associate professor of mathematics and coordinator for computer mathematics at York College of the City University of New York; he studied mathematics at M.I.T. and Brandeis. Send problems, solutions, and comments to him at the Department of Mathematics, York College, Jamaica, N.Y. 11451.

Doug McIlroy visited us today (27 August) from Bell Labs. After some shop talk about our research on parallel computers, he brought me up to date on BELLE, Ken Thompson's and Joe Gordon's computer chess machine. Their newest version evaluates an astounding one million chess positions per second! This is 100 times faster than any other computerized chess program in existence; extrapolating from these other programs, BELLE is probably playing master-level chess. The world computer chess championships will have been held in Europe by the time you read this, and I am anxious to see how the current champion (Aiken's and Slate's CHESS from Northwestern University) will fare against BELLE. The quality of play will certainty be very high.

William Butler has submitted a revised version of his **FEB 5** problem, which now has five calculators as well as five people. This corrected version appears as **NOV/DEC 3** below.

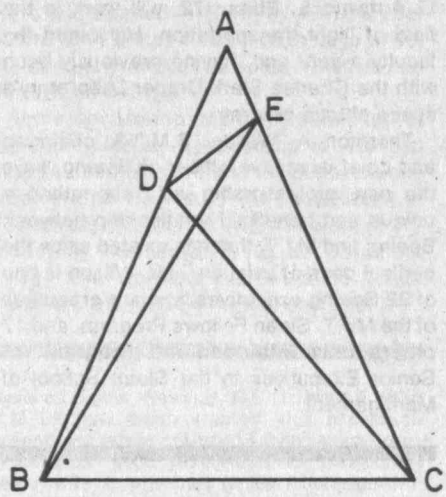
Problems

NOV/DEC 1 Rich Sieger wonders which reachable chess positions require the greatest number of moves to be reached.

NOV/DEC 2 A number-theory problem from Ted Clinkenbeard:
Suppose we are given the sequence
$S0 = \{1^n, 2^n, 3^n, \ldots\}$
and form the difference sequence
$S1 = \{2^n - 1^n, 3^n - 2^n, \ldots\}$
by taking the difference between consecutive elements in S0. Now form S2 as the difference sequence of S1, etc. Show that
$Sn = \{n!, n!, n!, \ldots\}$.

NOV/DEC 3 This is a revised version of **FEB 5**; two new (italicized) sentences have been added:
Five people had consecutive appointments with an income tax expert to help them fill out their 1040 forms and schedules. The electrical engineer had income from a savings account. The man who had a profit trading commodities was taking educational expenses as a deduction. When the man who contributed to a charity was leaving he met the taxpayer with dividend income. The biochemist is deducting interest on a mortgage. The computer programmer uses an SC-40 calculator. *When the man with the medical expense left, he met the man with the educational deduction. The man with four dependents owns a C1400 calculator.* The man with three dependents is claiming storm damage as a deduction. The man with the charitable deduction followed the physicist. The man with five dependents exchanged amenities with the owner of the SR-50. When he looked at the tax expert's calendar, the man with the MX-140 noticed his name was next to that of the man with three dependents. The man with seven dependents sold some real estate for profit. The mathematician has six dependents. The income tax expert still had more than one scheduled appointment after he met the man with dividend income. Each man had a profession, owned a calculator, had a deductible expense, had some number of dependents, and had a second source of income. Who won money in a contest? Who owned an HP-45 calculator?

NOV/DEC 4 Sheldon Katz has a geometry problem for us:



Given angle EBC = 60°, angle DCB = 50°, and AB = AC. Find angle DEB.

NOV/DEC 5 We close the problem department with a cryptarithmetic offering from Frank Rubin:
Replace each letter by a unique decimal digit to obtain a correct multiplication:

```
  SINK
  THEM
------
DEEPDEEP
```

Speed Department

SD 1 A carpentry "quickie" from James Landau:
For a production of *Crucible* the carpentry crew was asked to provide eight wooden stools. The master carpenter took a sheet of plywood 4′ × 8′ and proceeded to cut out eight 16″ × 16″ rectangles on a table saw and then asked me and the other assistant to nail on the legs which had been turned on a lathe the week before. When we said we were finished the master carpenter picked up a 16″ × 16″ piece of plywood and said we had missed one. We just laughed and pointed to the eight completed stools. What happened?

SD 2 A two-part problem from Charles Baker, which reminds me of the first "speed" problem I ever published (in the now-defunct *Tech Engineering News*, where "Puzzle Corner" started):

If a man and a half can dig a hole and a half in a day and half, how long does it take a half a man to dig half a hole? If an acre and a half can grow a foot and a half in a month and a half, how long does it take half an acre to grow half a foot?

Solutions

J/J 1 South's contract was four spades; the opponents made no bid.

North	*South*
♠7 6 3	♠K W 10 4 2
♥A 2	♥K Q 6
♦8 6 5 4	♦A 2
♣A 7 4 3	♣K 9 5

West opened with the ♦K. How does South win?

The following solution is from Robert Slater: South is going to lose the ♠A, one diamond, and one club. His entire problem thus becomes one of avoiding a second trump loser. There is no sense leading out winners: no squeeze will develop, nor can any meaningful discards be made. Therefore, South must assume that a trump distribution exists which will permit making the hand. There are 19 such distributions: any arrangement with three or more spades, including the ♠J, in the West hand will lose; also, ♠A 9 8 5 in the West hand will lose, as will all five trumps in the East hand. The "best chance" play is:

1. Take the opening lead.
2. Return a low heart to the ♥A.
3. Lead a low spade and (unless East goes up with the ♠A) go up with the ♠K or ♠Q.

If that holds (and at the first opportunity, at any event)

4. Return to dummy with ♣A and finesse again, this time playing the ♠10 (unless East lays the ♠J out there).

This approach will win every distribution that can be won except where West has specifically two clubs including the ♣J. It will win any time there are three clubs to the ♣J in East's hand.

Also solved by Doug Van Patter, Winslow Hartford, and the proposer, the late Elmer Ingraham.

J/J 2 Find all integral solutions to $x^2 + y^2 = z^2 + 1$.

Emmet J. Duffy has submitted the following solution:

For even values of x, $x = 2a$, $y = 2a^2 - 1$, $z = 2a^2$, where a is an integer. For odd values of x, $x = 2ab + 1$, $y = ab^2 - a + b$, $z = ab^2 + a + b$, where a and b are integers. These formulas do not give all values of x, y, and z, as the answer $x = 10$, $y = 15$, $z = 18$ cannot be obtained. To get all possible answers, rearrange the equation to:

$x^2 - 1 = z^2 - y^2$

$x^2 - 1 = (z - y)(z + y)$

Let $z - y = F_1$ and $z + y = F_2$. Then $y = (F_2 - F_1)/2$ and $z = (F_2 + F_1)/2$. Thus, take any value of x, square it and subtract 1. Factor the result, remembering that 1 and $x^2 - 1$ are factors. Factors must be both odd integers or both even integers. Half the difference of the factors is y and half the sum of factors is z. A surprisingly large number of prime numbers can be x, y, z. For $x < y < z$, here are some of them:

7	11	13	41	53	67
11	13	17	41	79	89
11	29	31	41	101	109
13	19	23	41	419	421
13	41	43	43	59	73
17	71	73	43	71	83
19	43	47	43	151	157
23	29	37	43	461	463
23	41	47	53	349	353
29	37	47	59	139	151
29	67	73	61	307	313
28	103	107	61	463	467
31	43	53			
31	239	241			

Also solved by Jeffrey Kenton, Robert Lutton, Irving Hopkins, Gerald Blum, Roger Milkman, Mark Lively, Avi Ornstein, Frank Carbin, Raymond Gaillard, Robert Slater, Winslow Hartford, Harry Zaremba, and David Freeman.

J/J 3 An army 40 miles long advances 40 miles while a messenger on horseback rides from the rear of the column to the front and back to the rear. How far has the messenger ridden?

Bob Metcalf did not have much trouble with this problem:

Let M = speed of the messenger, A = speed of the army, U = the messenger's time up to the front of the column, and B = the messenger's time back to the rear.

1. Assuming the army is standing still, the distance up to the front is $(M - A)U = 40$.
2. Assuming the army is standing still, the distance back to the rear is $(M + A)B = 40$.
3. The army travels 40 miles while the messenger goes up and back: $A(U + B) = 40$.
4. The net distance travelled by the messenger up and back is 40, too: $MU - MB = 40$. Adding (1) and (2) we get $M(U + B) = 80 + A(U - B)$. $M(U + B)$ is what we want — the messenger's total distance. Using (3) to substitute for A and using (4) to substitute for $(U - B)$ we get:

$M(U + B) = 80 + 40/(U + B) \cdot 40/M$.

Collecting $M(U + B)$ as X we get:

$X^2 - 80X - 1600 = 0$.

Solving for X we get our answer:

$X = 40(1 + \sqrt{2}) = 96.57$ miles.

Also solved by Emmet Duffy, Jeffrey Kenton, Mark Lively, Gerald Blum, Robert Lutton, Kenneth Kellogg, David Krohn, James Landau, an anonymous self-proclaimed procrastinator, Kenneth Amer, Naomi Markovitz, Avi Ornstein, Everett Leroy, Ken Arbit, Douglas Szper, Ronnie Rybstein, Robert Slater, Peter Sorant, Kelly Woods, Timothy Maloney, David Simen, Winslow Hartford, Liland Jackson, Harry Zaremba, Michael Jung, George Flynn, Mary and Martin Lindenberg, David Freeman, Anne Symanovich, Erik Anderson, Danny Mintz, Charles Swift, and the proposer, John Prussing.

J/J 4 How many one-on-one comparisons would be needed to order by specific gravity six liqueurs if no two have the same specific gravity? Should they be compared individually or in groups?

This problem (when all the circumstances are simplified) asks you to sort six numbers using the minimum number of comparisons. As several readers remarked, the number of comparisons depends somewhat on luck. For example, suppose that you compare A with B finding B greater and then compare B with C finding C greater. With these two comparisons you have determined that $A < B < C$. But if you compare A with B finding B greater and then compare B with C finding B greater, you still must compare A with C. If you are maximally lucky, you can get by with $N - 1$ comparisons — in this case 5. The total number of possible comparisons is $\binom{N}{2}$, in this case 15.

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The intent of the problem is to devise a comparison method "independent of luck." This has two common interpretations: a method that minimizes the number of comparisons in the worst case, and a method that minimizes the number of comparisons in the average case. David Freeman solved the worst case problem; no one tried the average case. Mr. Freeman, who needed only ten comparisons (whereas most readers needed 11), was aided by first determining the "best possible" results. Since he achieved these lower bounds, balancing in groups cannot help. Mr. Freeman's solution follows. Since for N items N! orderings are possible, at least k(N) binary comparisons are required to distinguish all cases, where
N! < 2**k(N).
Specifically, we have

N	*k(N)*
1	0
2	1
3	3
4	5
5	7
6	10

We claim that these lower bounds can be achieved for N < 7.
If N = 3, compare a and b and find, for example, a < b (b < a is similar). Then compare a and c; if c < a, c < a < b. If a < c, compare b and c; if b < c, a < b < c; if c < b, a < c < b. Thus we can sort with three comparisons.
If N = 4, three comparisons gives a < b < c. Then compare d and b; if b < d, compare d and c to determine a < b < c < d or a < b < d < c. If d < b, compare d and a to determine a < d < b < c or d < a < b < c. Thus we can sort with five comparisons.
If N = 5, we cannot start from the N = case; this is the only nontrivial step. Two compares give a < b and c < d. Compare a and c and find, for example, a < c (c < a is similar). Then compare c and e. If c < e, compare d and e. If d < e, we have a < c < d < e and a < b; as with N = 4, we can add b to c < d < e with two compares. If e < d, reverse labels d and e and proceed as above. If e < c, compare a and e. If a < e, we have a < e < c < d and a < b; as with N = 4, we can add b to e < c < d with two compares. If e < a, we have e < a < c < d and a < b; as with N = 3, we can add b to c < d with two compares. In every case, seven compares were used.
If N = 6, seven compares gives a < b < c < d < e. Now compare c and f and find, for example, c < f (f < c is similar). Compare d and f; if f < d, a < b < c < f < d < e. If d < f, compare e and f; if e < f, a < b < c < d < e < f; if f < e, a < b < c < d < f < e. Thus we can sort with ten comparisons.
Since we achieve the minimum with simple weighings, no improvement is possible with other binary strategies, such as comparing in groups.

Also solved by Ken Arbit, Winslow Hartford, Jeffry Kenton, Gerald Blum, Robert Lutton, Naomi Markovitz, Avi Ornstein, Timothy Maloney, and John Prussing.

J/J 5 On a train, Smith, Robinson, and Jones are the fireman, brakeman, and engineer, but *not* respectively. Also aboard the train are three businessmen who have the same names — a Mr. Smith, a Mr. Robinson, and a Mr. Jones.
1. Mr. Robinson lives in Detroit.
2. The brakeman lives exactly half way between Chicago and Detroit.
3. Mr. Jones earns exactly $20,000 per year.
4. The brakeman's nearest neighbor, one of the passengers, earns exactly three times as much as the brakeman.
5. Smith beats the fireman at billiards.
6. The passenger whose name is the same as the brakeman's lives in Chicago.
Who is the engineer?

William Grosky sent us a nice, neat solution: By 1., Mr. Robinson lives in Detroit. 6. implies that a passenger lives in Chicago; thus, by 2. and 4., the brakeman's nearest neighbor, a passenger, does not live in Chicago or Detroit and is either Mr. Jones or Mr. Smith. By 4. again, either Mr. Jones or Mr. Smith earns exactly three times as much as the brakeman; but $20,000 is not exactly three times any salary. Thus 3. implies that Mr. Smith is the brakeman's nearest neighbor. Using 6., we then have that Mr. Jones lives in Chicago, and thus the brakeman is named Jones. 5. implies that the fireman is Robinson. Thus the engineer is Smith.

Also solved by Winslow Hartford, Avi Ornstein, Gerald Blum, Anne Symanovich, Charles Swift, Peter Sorant, Naomi Markovitz, Robert Lutton, Timothy Maloney, David Freeman, Danny Mintz, Robert Sutton (Robert Sutton is distinct from Robert Lutton), Mike Bercher, Wes Harper, Robert Slater, Thomas Sico, Rich Rosen, Bill Kaiser, Dick Schulze, Al and Jeanne Bloam, Harry Zaremba, Mary and Martin Lindenberg, Michael Jung, David Simen, Kelly Woods, Ronnie Rybstein, Douglas Szper, an anonymous self-proclaimed procrastinator, James Landau, David Krohn, Raymond Gaillard, and Mark Lively.

Better Late Than Never

NS 19 Robert McKean has responded.
FEB 4 Harry Zaremba notes that in the parametric equation for x, the theta term should have a coefficient of 2.
MAY 1, 2, 3, and **4** Richard Hess has responded.
J/J SD 1 Robert Kruger notes the meaning of "meet" allows the boats to meet twice before either has reached the opposite shore.

Proposers' Solutions to Speed Problems

SD1 The master carpenter had taken the 4′ × 8′ sheet of plywood and cut it three times crossways to give himself three 16″ × 48″ strips (and a 4′ × 4′ piece left over) — the only feasible way to handle sheet plywood on a table saw. The first two strips were cut into thirds to give six tops; the third strip also produced three pieces 16″ × 16″.
SD2 (Courtesy of the editor) A day and a half; a half month.

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Without physical capital, it is impossible to translate new knowledge into new output.

tivity fell sharply from 6.3 percent per year to 1.3 percent per year.

Here again there is an easy explanation but not an easy solution. Utilities employ most of their workers in maintaining their distribution network; relatively few are employed producing gas or electricity. When average household consumption is increasing rapidly, productivity rises dramatically. Output is up, but more workers do not have to be employed since the extra output can be distributed through the existing distribution network. But when household consumption falls, productivity falls. Less output is being produced, but the same work force is necessary to maintain the distribution network.

Utility productivity is a simple, direct function of the rate of growth of output. If output grows rapidly, as it did from 1948 to 1965, productivity grows rapidly. If output grows slowly, as it did from 1972 to 1978, productivity grows slowly. If output falls, as it did in 1974 and 1977, productivity falls.

Utilities account for another 8 percent of the national productivity decline, but as with oil depletion, this is a difficult problem to remedy. If energy prices rise rapidly, energy consumption will fall — it is even a national policy to make it fall — and when consumption falls or slows, productivity must fall.

Together mining and utilities represent the direct "energy" blow to productivity. The decline in oil productivity is one reason why energy prices are up, and higher energy prices lead to lower utility productivity. When we include the indirect effects of devoting investment funds to saving energy rather than raising labor productivity, energy problems are responsible for about 20 percent of the national productivity decline.

A Disheartening Reflection

Services are the mirror image of agriculture: agriculture was a rapidly declining low-productivity industry; services are a rapidly growing low-productivity industry. While agriculture enhanced productivity growth, services are dampening it.

Services have acted as a brake to productivity growth since World War II, and the brakes have gradually tightened as service productivity has fallen relative to the national average. Moving workers into services lowered productivity only 4 percent in 1948. But by 1978, service productivity had fallen to 62 percent of the national average: workers moving into services represented a 38-percent decline in productivity.

From 1972 to 1978, services absorbed 35 percent of all the hours of work added to the private economy. Of these 5.7 billion work hours, 42 percent went into health care, largely into nursing homes, and 27 percent went into business services (lawyers, accountants, consultants).

The reason for the low productivity of services can be readily illustrated. For example, since 1972, an extra 150,000 private security guards have been added to the economy to guard existing output, thereby adding hours of work while doing nothing to increase output. The result: declining productivity.

If services had not grown from 1972 to 1978, about 5 percent of the observed decline in national productivity would have disappeared. But the problem of adding nursing homes, lawyers, and security guards illustrates the difficulties of dealing with service productivity. Bathing and feeding old people may be a low-productivity occupation, but each of us wants to be bathed and fed when old. Lawyers may be a drag on productivity, but we are all using them in increasing numbers. Productivity statistics do not care whether you or some thief has your new stereo, but you care.

Inflation, the Baby Boom, and Capital Investment

Particular problems in agriculture, construction, mining, utilities, and services explain about 57 percent of the productivity decline between the first and third economic periods. Most of the remaining 43 percent can be traced to the interaction of two other factors: the policies used to fight inflation, and the baby boom.

The amount of equipment per worker — the capital-labor ratio — is a key ingredient in productivity growth. Better-equipped workers can produce more output per hour, but new capital is also a carrier of new technologies. To put new, more productive technologies to work, workers must be provided with the equipment that embodies those new technologies. Without this additional hardware, or "physical capital," it is impossible to translate new knowledge into new output.

The U.S. capital-labor ratio grew by 2.8 percent per year from 1948 to 1965, accelerated to 3.2 percent per year from 1965 to 1972, and then plunged

A necessary accompaniment to more investment is less consumption.

to 1.4 percent per year from 1972 to 1978. In 1978 the capital-labor ratio actually fell 1.3 percent. But this growth slowdown did not occur because Americans were investing less. From 1948 to 1965 Americans invested 9.5 percent of the GNP in private plants and equipment, but in the next two periods they invested 10.3 percent of the GNP. The capital stock was actually growing slightly faster from 1972 to 1978 than from 1948 to 1965 (3.4 versus 3.3 percent), but the labor force was growing much faster as the post-World War II baby boom came of employable age.

The growth in hours worked gradually accelerated from a yearly rate of 0.4 percent from 1948 to 1965 to a yearly rate of 1.1 percent from 1965 to 1972, and to a yearly rate of 2.1 percent from 1972 to 1978. With a fivefold increase in the growth rate of the private labor force, and only a slight increase in plant and equipment investment, it is clear that a sharp slowdown in the growth rate of the capital-labor ratio has occurred.

The problem was nicely illustrated in 1978. Americans invested 10.4 percent of their GNP in plant and equipment that year and capital stock rose 3.4 percent. But hours of work rose 4.8 percent and the capital-labor ratio fell 1.3 percent. When the data for 1979 are available, they will undoubtedly reflect an even larger reduction in the capital-labor ratio.

Pollution and energy problems may also be compounding the decline in the capital-labor ratio. When capital investment is used to control pollution or cut energy use, there is less investment available to raise productivity. No hard estimates exist on how much of our plant and equipment investment has gone into energy savings since 1972, but about 5 percent has gone into pollution controls.

If pollution and energy expenditures were excluded from capital investment, the slowdown in the growth rate of the capital-labor ratio would be even sharper. But even without considering the investment drained off to fight pollution and cut energy use, the observed slowdown in the growth of equipment per worker explains about 20 percent of the productivity decline.

Accelerating the growth of the capital-labor ratio would have required Americans to invest a much larger fraction of their GNP in plant and equipment. There is less equipment per worker not because Americans are investing less, but because there are many more Americans in the labor force. A necessary accompaniment to more investment is less consumption. And less consumption inevitably means a sharp reduction in standards of living until the baby boom has been equipped with capital, until pollution has been brought under control, until energy use has been reduced to levels appropriate to the price of energy, and until America has caught up with the new technologies employed by Germany and Japan.

It is important to understand that the slowdown in the growth of the capital-labor ratio was not a mistake, but a perfectly rational response to the economic facts of life. Firms invest to raise the capital-labor ratio when it is profitable to do so. When the cost of capital falls relative to the price of labor, firms find it cheaper to raise production by investing in capital than by hiring more workers. The result is a rising capital-labor ratio. But when capital becomes more expensive relative to workers, firms find it cheaper to raise production by hiring more workers, causing the capital-labor ratio to fall.

Economic signals have called for a slowdown or reduction in the capital-labor ratio. Looking at just the purchase price of new capital equipment relative to the compensation (wages plus fringe benefits) of labor, the price of capital was falling 2.7 percent per year relative to the price of labor from 1948 to 1965. But from 1972 to 1978, the relative price of capital was falling at a rate of only 0.7 percent per year.

The purchase price of new capital equipment is only part of its total cost. Energy is required to run capital equipment and the price of energy becomes part of the total cost of acquiring and using capital. If energy costs are included, capital became cheaper relative to labor at the rate of 2.9 percent per year from 1948 to 1965 (energy prices were falling). But from 1972 to 1978, energy prices rose, and the cost of physical capital increased relative to that of labor at the rate of 2.9 percent per year.

If financing charges — the interest that must be paid to borrow the money to buy the capital equipment — are included along with energy and purchase prices, the turnaround is even more dramatic. While total capital costs fell 1.1 percent per year relative to total labor costs in the first period, total capital costs rose 4.2 percent per year relative to total labor costs in the third period.

Given such a sharp shift in the movement of

Industry	Output per manhour 1948 (1972 dollars)	Percent of the national average	Output per manhour 1978 (1972 dollars)	Percent of the national average
Agriculture, forestry, fisheries	1.48	40	4.96	60
Mining	6.04	161	11.30	138
Construction	4.16	111	5.85	71
Nondurable manufacturing	3.44	92	8.67	106
Durable manufacturing	4.25	114	8.49	104
Transportation	4.15	110	9.09	111
Communications	4.15	110	20.66	252
Electricity, gas, sanitary services	5.66	151	21.79	266
Wholesale trade	4.51	121	10.09	123
Retail trade	2.74	73	5.18	63
Finance, insurance, real estate	15.01	401	23.49	286
Services	3.58	96	5.07	62
Average	3.74	100	8.20	100

The level of productivity of various private industries in 1948 and 1972. The table illustrates an absolute increase in productivity, to which communications, utilities, and finance contributed most significantly. Mining, services, and retail trades showed the slowest productivity growth in these two decades.

prices, it is not surprising that there was a distinct slowdown in the rate of growth of the capital-labor ratio. Business was doing exactly what economic incentives were demanding.

While investment has not fallen, there is an easy explanation for why it has not risen faster. America has attempted to stop inflation with slow growth and tight monetary and fiscal policies. Whatever their effectiveness in stopping inflation, these policies retard investment in a number of ways.

As already shown, tight monetary policies raise interest rates and directly increase the cost of capital. Corporate bond rates have gone from 3.5 percent in the 1950s to well over 10 percent. When capital costs (including interest costs) rise, firms invest less.

But deflation also means recession, falling production, and idle capital capacity. Why should firms invest in more capital capacity when they already have vast amounts of idle capacity? They shouldn't, and very few do. The result is less capital per worker.

While rising interest rates increase the cost of

Part of the reason that Japanese and German productivity has grown so rapidly since World War II is that firms have had to operate under the strain of perpetual labor shortages.

capital during recessions, recessions are known to curb inflation by retarding wage increases. With high unemployment, union workers cannot win high wage increases. With surplus labor available, nonunion employers have no incentive to give wage increases. To the extent that this anti-inflation policy succeeds, it lowers the relative price of labor. With capital rising in price and labor falling in price, firms have every incentive to invest less. The baby boom kept wages from rising relative to capital costs in the 1970s as fast as in the 1950s, and anti-inflationary policies exacerbated the problem.

Recessions and higher unemployment have a direct impact on productivity. In common mythology, recessions cause firms to double their efforts to improve productivity: since they cannot increase sales, they focus on cutting costs. While some of this effect undoubtedly exists, the actual impact of recessions is very different.

When output falls, firms cannot or do not fire overhead labor (managers, sales and design staffs, researchers) as fast as output falls. Skilled workers are kept on the payroll long after they are needed because firms worry that they will not be able to woo them back in the next boom. Add to this the costs of massive firings (morale problems, severance costs, psychological distress for both firer and firee) and it is easy to understand why labor is not fired as fast as output falls.

Productivity grows most rapidly when output is growing rapidly and all these factors are reversed. Workers kept on the payroll are put back to work, and production goes up without the hiring of more labor. But labor shortages also induce new efforts to find more efficient, capital-intensive methods of production. Part of the reason that Japanese and German productivity has grown so rapidly since World War II is that firms have had to operate under the strain of perpetual labor shortages.

Regardless of tax incentives, investment takes place only in an atmosphere of economic growth. If the nation deliberately interrupts economic growth to stop inflation, it will inevitably stop investment.

Declining R&D Expenditures

Research-and-development expenditures fell from 3 percent of the GNP at the beginning of the 1970s to 2 percent of the GNP at the beginning of the 1980s, but this decline explains very little of the observed decline in productivity. Productivity growth decelerated after 1965, well before any cutback in research expenditures. There are also long lags between research-and-development expenditures and measured productivity. Products must be invented, production processes must be developed, factories must be built, and the industry must grow to a size where it can have a measurable impact on aggregate productivity.

Cutbacks in research and development will undoubtedly have an adverse effect on productivity, an impact yet to be felt in full force. Most of the factors that caused productivity to fall in the 1970s will be with us through the 1980s, and their impact will be augmented by the effects of lower research-and-development expenditures.

An Inexperienced Labor Force

Because of the baby boom and the growing female labor force, American business and industry were flooded with inexperienced workers in the 1970s. This inexperience was counterbalanced, however, by the generally high level of education of these younger workers.

If inexperienced workers were at the heart of the problem, the biggest productivity declines should have occurred in the industries that hire the most women and younger workers. The industries with sharp reductions in productivity growth are not, however, the industries that hire a lot of women and young people. Hence, while an inexperienced labor force may have played a small role in slowing productivity, it was not an integral cause.

Inhibiting Rules and Regulations

Government regulations also are only a minor and indirect part of the problem. Government regulations probably explain about 20 percent of the decline in mining productivity. Five percent of the nation's capital investment has been siphoned off to help control pollution. Indecision over nuclear power may be part of the problem in construction. Government cutbacks in research support will affect productivity in the 1980s. But government regulation is hardly a major factor in the general decline of productivity. Manufacturing, an industry that has enjoyed relatively good productivity growth in the 1970s, is also the industry most subject to govern-

ment regulation. If government is to be blamed at all, it should not be for its regulations but for its shortsighted macroeconomic policies.

Possible Solutions

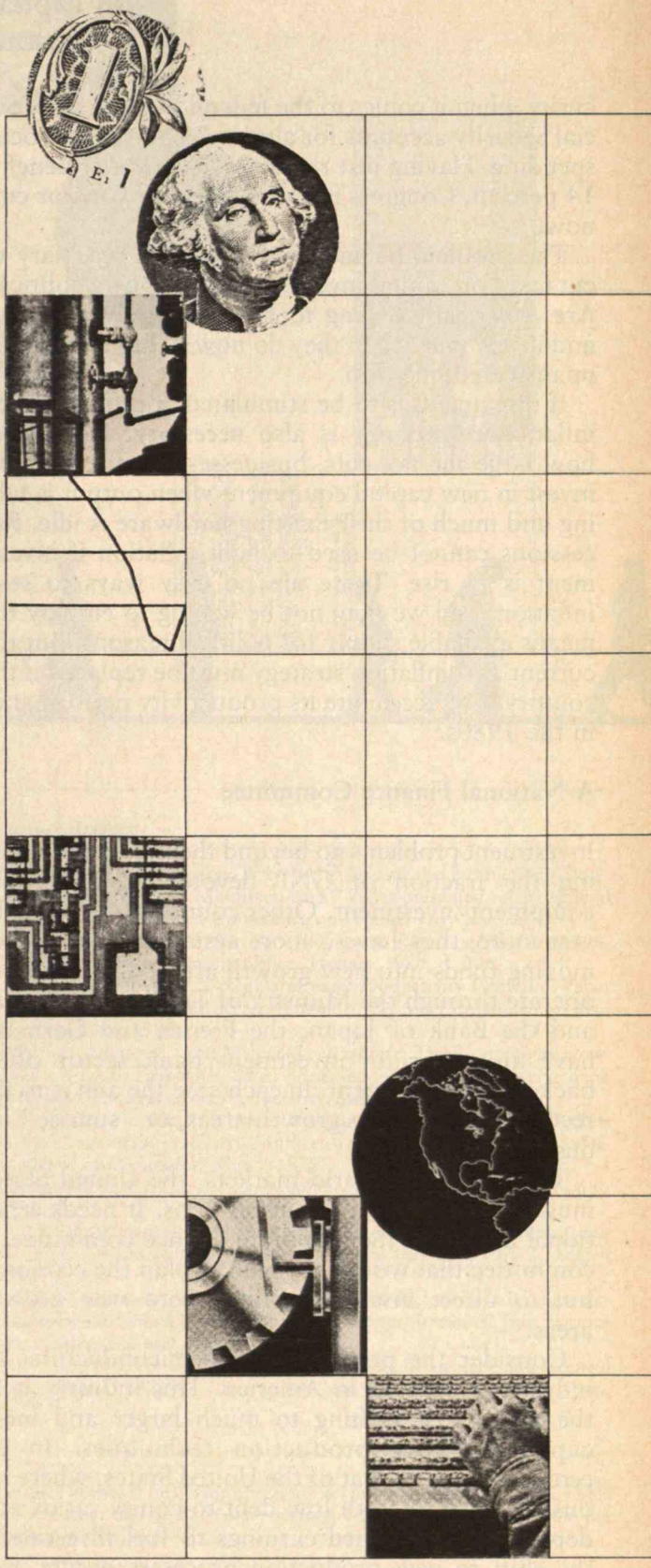
It is clear that declining productivity cannot be countered simply by "reversing" its causes. Most of the decline due to agriculture, mining, utilities, and services is irreversible. The decline due to construction may or may not be reversible, depending on how the mystery is resolved. Research-and-development expenditures could and should be brought back to their old levels, but this will be of more help in the 1990s than in the 1980s because of the lag between investing in R&D and experiencing its payoffs. Nothing can be done about the age or sex mix of the labor force. Pollution and safety controls are basically here to stay.

Hence, if only by default, attention inevitably focuses on investment. If investment could grow more rapidly, it would offset other negative factors and lead to a higher rate of productivity growth. Every extra percent of GNP devoted to plant and equipment investment raises the growth of productivity by approximately 0.2 percent. And since new investment allows the country to use new technologies, the gains may eventually be even greater.

Theoretically, it is easy to stimulate investment. If the tax system were biased in favor of capital investment — by reducing the corporate income tax, accelerating depreciation, or a host of other possible investment tax credits — and the economy were operated on some reasonably consistent long-run growth path, there is little doubt that investment would increase.

But to provide the funds necessary to bias the tax system in favor of capital is to bias it against consumption. To pay for massive investment tax cuts, consumption taxes would have to be raised. Here again there is no technical problem in bringing about the desired changes. A value-added tax (essentially a national sales tax) could be adopted to discourage consumption and raise the revenue to pay for investment tax credits. Alternatively, the revenue could be raised by cutting defense or social programs.

None of these measures is likely to be taken, however. Pressures now exist to raise defense spending, and "social programs" is a euphemism for Social Se-



The problem of finding the revenue necessary to cut taxes on capital investment is obviously political.

curity when it comes to the federal budget, since Social Security accounts for almost 75 percent of social spending. Having just raised Social Security benefits 14 percent, Congress is hardly likely to vote for cuts now.

The problem of finding the revenue necessary to cut taxes on capital investment is obviously political. Are Americans willing to force themselves to save and invest more than they do now? That remains an unanswered question.

If investment is to be stimulated, a different anti-inflationary strategy is also necessary. No matter how large the tax cuts, businesses are not going to invest in new capital equipment when output is falling and much of their existing hardware is idle. Recessions cannot be used to fight inflation if investment is to rise. There are no easy ways to stop inflation, and we may not be willing to employ the means available simply for political reasons. But the current anti-inflation strategy must be replaced if the country is to accelerate its productivity performance in the 1980s.

A National Finance Committee

Investment problems go beyond those of simply raising the fraction of GNP devoted to plant and equipment investment. Other countries not only invest more, they have a more systematic method of moving funds into new growth areas. The Japanese operate through the Ministry of Trade and Industry and the Bank of Japan; the French and Germans have an important investment bank sector often backed by government. In each case the aim is to direct capital into new growth areas, or "sunrise" industries.

To compete in world markets, the United States must develop equivalent institutions. It needs a national analog of the corporate finance committee, a committee that would not seek to plan the economy but to direct investment funds into new growth areas.

Consider the production of semiconductors, an industry pioneered in America. This industry is in the process of shifting to much larger and more capital-intensive production techniques. In an economy such as that of the United States, where industries operate with low debt-to-equity ratios and depend upon retained earnings to fuel investment, the shift to new production processes occurs at a pace limited by current profits.

But the Japanese are entering this industry with massive debt capital lent by the Bank of Japan. Their aim is to jump directly into large-scale, capital-intensive production techniques, sell at prices lower than those of the rest of the world, and capture most, if not all, of the market. If American industry limits its investments to those that can be financed by retained earnings, it will simply be driven out of computer and semiconductor manufacturing, as Japan publicly announced.

The problem cannot be solved by pretending that it does not exist. American industry simply will not be able to compete in the modern world of international trade without changes in the way it has traditionally operated. Maybe America would be better off if other governments did not engage in investment banking, but they do. Unless a country is able to take advantage of product innovations and develop large-scale sunrise manufacturing industries to replace its large-scale sunset industries, it does very little good for that country to be the first to develop a new product.

Many observers have criticized the idea of a national corporate investment committee on the grounds that it would be used to prop up sunset industries that are better left to die. No doubt there is a real danger that the committee would be used to bolster the steel and textile industries rather than computer-chip concerns. Yet this criticism reflects incredible pessimism about the ability of Americans to compete and adjust to new economic facts of life. The critics are saying that Americans cannot compete in international markets as we are now organized, and that we are so incompetent that we cannot reorganize to compete. Maybe this diagnosis is correct, but it would be a shame to accept it without even attempting to overcome existing barriers to an efficient industrial policy.

The root of this problem is disinvestment. Disinvestment, or getting out of old sunset industries, is just as important a source of growth as getting into new sunrise industries. But in the last five years, the U.S. government has been heavily involved in propping up sunset industries. Steel, television manufacturing, textiles, cheese making, the Chrysler Corporation — all exist chiefly because of government help. While the American government was designing policies to keep outdated steel mills open, the Japanese government was forcing the Japanese steel

industry to close 10 percent of its least-efficient plants. This situation cannot continue if America is to compete.

But given the political realities, it is possible to disinvest only in an economy that has a good investment strategy and is growing rapidly. In such an environment, it is relatively easy to move funds and people into new growth areas. Thus, if the auto and steel industries are wilting in the heat of a recession, but there are no job opportunities in other areas, the political process has no choice but to prop up these sunset industries.

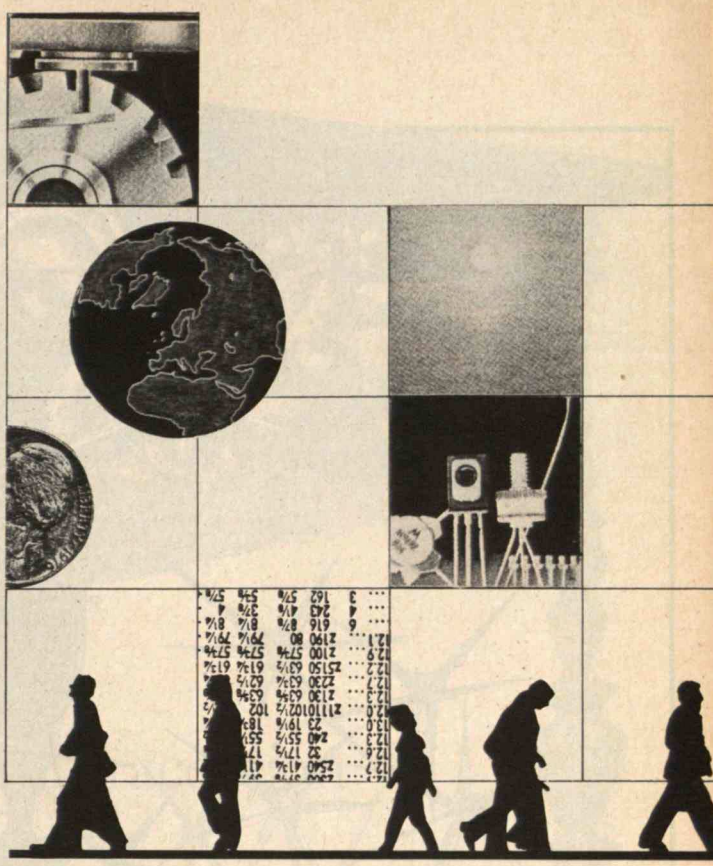
The Rough Road to Economic Resurrection

If real standards of living are to resume their upward course, productivity growth must be restored. But if we are to compete in international markets with the Japanese and Germans, productivity must not be restored merely to its old levels but raised to a height never before achieved.

This will not be easy. If an autopsy on American productivity were written, it would list the cause as "death by a thousand cuts." There is no one factor to which the decline can be attributed; there is no magic button that can be pushed to resurrect the economy. The cure will require a thousand treatments for each of the thousand cuts. And each ministration will be painful and resisted by some vested interest. Everyone wants a cure to the productivity problem, but everyone wants the cure to be imposed on someone else. If we cannot find the political will to impose the cost upon ourselves in a fair manner, we simply will not solve the problems.

It is clear that the solution will not be found by looking back to the "good old days." The "good old days" aren't good enough to compete in today's world, and some very real factors (the end of cheap energy, the completion of the shift from agriculture to industry) have made it impossible to turn back the clock.

The United States will have to develop new industries and new techniques for managing its economy if it is to survive. There is nothing in the stars that gives America a permanent right to the number-one economy. It wasn't always so (American per-capita GNP did not exceed that of Great Britain until around 1900), it isn't so now, and it may never be so again.



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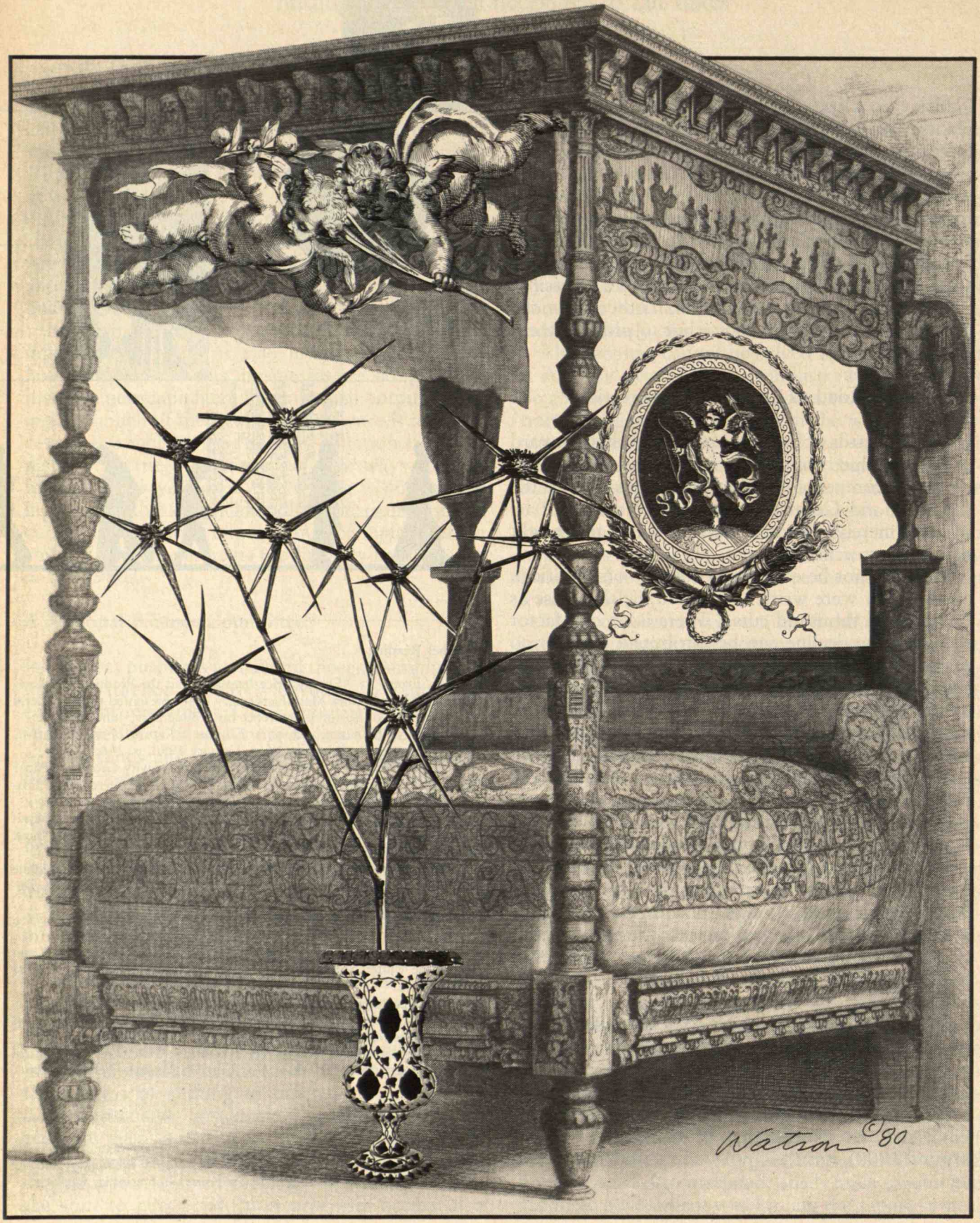
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Illustrations: Karen Watson

A variety of new techniques is under development to broaden the number of options and to break the "axiom" that risk increases with effectiveness.

New Directions for Contraception

by Carol C. Korenbrot

At the peak of its popularity in the early 1970s, more than 50 million women throughout the world were using "the Pill" — the collective term for oral contraceptives. A main factor in the Pill's initial wide acceptance was the assurance that its pharmacological side effects were no more serious than those of most drugs and a lot less serious than some. But we came to the slow and painful realization that when large numbers of healthy people take a drug daily for long periods of time, its safety must be evaluated differently. With millions of consumers, even "rare" side effects occur all too frequently. Furthermore, the Pill is not a drug to prevent or ameliorate a disease but to prevent a natural physiological condition with important personal, social, and cultural consequences.

The lesson learned in the 1970s from experiences with the Pill, the Dalkon Shield (an intrauterine contraceptive device) and DES (diethylstilbestrol, a drug erroneously believed to *maintain* pregnancy) was not unlike that now being learned from saccharin, "Agent Orange," and even Three Mile Island: assessments of technological innovations must consider both "risk" and "safety." Risk is the likelihood of an adverse effect, while safety is the judgment of risk *acceptability*. The measurement of risks is largely the scientist's realm, but the evaluation of safety is a personal and social process that can be done by anyone who examines the risks. For example, it is not surprising that the Pill's utilization began to drop soon after Great Britain's Royal College of Physicians and Surgeons made public an extensive analysis of its health risks (*see "The Pill and the Pendulum" by Ruth Hubbard and Nancy Krieger, August/September, p. 12*).

It has been virtually axiomatic that the more effective a contraceptive, the greater its risks. Contraceptive failure rates (during the first 12 months of use by married women 15 to 44 years of age) are calculated to be only 2 percent for the Pill, 3 percent for surgical sterilization, and 5 percent for intrauterine devices, but these methods have the highest incidence and severity of side effects. Health risks for vaginal and barrier contraceptives, on the other hand, are rare and minor, but failure rates are high: for the diaphragm in combination with spermicidal jelly, 13 percent; for the condom, 15 percent; and for contraceptive foam or jellies alone, 20 percent. Rhythm and coitus interruptus, although practiced effectively by some, have even higher failure rates.

Newer approaches to the very old "rhythm method" involve almost no risk but illustrate the need for enhanced user education.

Current research-and-development efforts seek contraceptive techniques that violate the "axiom" or broaden the options so that people can choose the methods most acceptable to them. We are not likely to see a "breakthrough" like the Pill in the near future as a result of these efforts. But we can expect an increase in the variety of contraceptives: new drugs and new methods of administration of old drugs, as well as innovative surgical techniques and mechanical devices for both males and females. What follows is a sampling of these approaches and their expected benefits and potential risks.

Contraceptive Drugs for Women

Neurohormones. The 1977 Nobel Prize for Physiology or Medicine was shared by three American biomedical researchers, two of whom — Roger Guillemin at the Salk Institute and Andrew Schally at Tulane University — had independently identified hormones secreted in the brain that in turn modulate the hormones of the pituitary gland. The pituitary gland, located just under the brain, had long been believed to be the "master gland" of the body, secreting hormones to regulate many other parts of the body. The work of these researchers, however, showed that the brain secreted hormones — neurohormones — that rendered the pituitary gland a "servant" to hormonal input like all other glands.

One of the first of these brain hormones to be chemically identified was gonadotropin-releasing hormone (GnRH), which stimulates the release of the pituitary gonadotropins, which in turn stimulate the reproductive glands (milligrams of the hormone were isolated from hundreds of thousands of slaughterhouse animals). Work began soon thereafter to find chemically modified analogs of GnRH for use as contraceptives, and very potent analogs were found that inhibit the pituitary glands of women from secreting gonadotropic hormones. The major route of administration of these analogs is a nasal spray, which is absorbed through the lining of the nasal passages and circulates at high concentrations in the head near its target, the pituitary.

There have been no published studies on how often the nasal spray would have to be used, nor on its efficacy in preventing pregnancy. A number of potential problems need to be worked out. For example, the GnRH analogs, chemically similar to other substances in the brain, may also affect other brain functions. Most researchers in the field consider current work with neurohormones about as advanced as research on estrogens and progestins for the Pill in the 1940s — in other words, at its earliest stages.

Prostaglandins. Although there was reference in the scientific literature as early as 1920 to a substance in the perspiration of menstruating women that had the "power to wither roses," it was not until 1957 that these "menstrual toxins" were actually identified as prostaglandins. In the meantime, the prostaglandins had been discovered and chemically identified in the male prostate gland, for which they are named. The two prominent functions of prostaglandins in female reproduction are to increase uterine contractions and to block the production of a hormone (progesterone) necessary for sustaining pregnancy during its initial weeks. Both functions mean that prostaglandins — which, like neurohormones, can be synthesized and modified in laboratories — could provide a means to early termination of pregnancy.

Recent clinical trials in Sweden showed that induction of uterine contractions by a synthetic prostaglandin in vaginal suppositories could terminate 99 percent of the pregnancies of less than 50 days' duration. Theoretically, if this drug were the only contraceptive used by a fertile woman having intercourse four times a week, the drug would be required only three times a year for her expected three pregnancies.

But side effects are acute: pain, vomiting, diarrhea, and vaginal bleeding normally follow the procedure and continue for several days (although other drugs could counteract these effects). Risks with this procedure include the possibility of incomplete abortion and endometritis (inflammation of the uterine lining). Furthermore, the side effects and risks of prostaglandins increase as the duration of pregnancy increases, and potential effects on subsequent pregnancies are yet to be investigated.

An alternative use of prostaglandins would be to block production of progesterone, thereby inducing menstruation each month in which there was a risk of pregnancy. Although several such analogs are being tested, none has been reported that lowers progesterone levels without first inducing uterine contractions.

Vaccines. The developing placenta in the uterus secretes a hormone that stimulates production of the

progesterone necessary to sustain pregnancy. Chemical agents to specifically inactivate the placental hormone (such as its antibodies) would thus interrupt pregnancy. Their injection produces inactivation of the hormone within days, but this lasts only a few weeks because the antibodies are destroyed in the blood. Limited trials of such vaccines using pregnant monkeys have showed that more than 80 percent of the pregnancies were terminated but that subsequent pregnancies were more likely to end in spontaneous abortions.

Antibodies with greater possibilities but more difficult to produce are those made for the progesterone itself. Although the effect has thus far been shown only in rats, a nonbiodegradable capsule containing the antibody could be ingested, and theoretically bind enough progesterone as it passed through a woman's digestive tract, to terminate her unwanted pregnancy.

Sex-Steroid Hormonal Delivery. Methods for slowly and uniformly releasing sex-steroid hormones like those in the Pill over long periods would eliminate the need for daily pill-taking and could increase overall effectiveness. These include injectables, implants, and vaginal rings. Injectable preparations consist of liquid depots injected into muscle from which the hormone is slowly released for months. Implants consist of cylindrical capsules of specialized plastics containing hormones placed under the skin. These implants provide effective contraception for from one to five years. Vaginal rings are hormone-containing plastic tubes placed in the vagina effective for from one week to three months. Unlike injections or implants, the ring can be removed by the user to reverse any side effects, or when pregnancy is desired.

Long-term use of hormones, even progesterone, does have associated risks. Most studied of the new methods of delivery is the injectable medroxy progesterone acetate — known under the Upjohn Drug Co.'s trade name of DepoProvera. While sustained circulating levels of this progestin usually produce a cessation of menstrual periods, many women experience unpredictable episodes of vaginal bleeding. These episodes apparently become less and less frequent with continued use. Estrogens can be administered to modulate the bleeding, but repetitive estrogen treatments produce side effects of the Pill.

Adverse effects discovered during toxicological testing of Depo-Provera include:



Prompted by increased concern over drug- and surgery-related risks, barrier methods are being developed that will be more effective than the condom and diaphragm.

☐ Malignant breast tumors in dogs.
☐ Long-term infertility in some women.
☐ A possible risk of cervical cancer in women (inconclusive evidence).
☐ A chance of birth defects in babies born to women exposed to the drug early in pregnancy.
☐ Side effects such as weight gain, acne, hair loss, and depression.

In 1978, the U.S. Food and Drug Administration (FDA) decided that the risks of Depo-Provera outweighed the benefits, especially since alternative contraceptives with similar efficacy were available, and its approval as a new drug was denied. However, the drug is still used in Brazil and other developing countries.

The ten-year toxicology studies in monkeys (required by the FDA of certain new hormonal contraceptives) were not completed for Depo-Provera until after the 1978 decision. Some of the monkeys treated with Depo-Provera developed endometrial cancer, but a controversy on the quality of this evidence minimized its effect. In fact, Depo-Provera may become the next new contraceptive generally available: a board of inquiry, established by the FDA, will soon decide whether the denial of approval should be reversed.

Vaginal Contraceptives. Drugs administered through the vagina are absorbed by the body slowly, thus minimizing the number and severity of side effects. Spermicidal preparations have long been used vaginally, and now there is renewed interest in finding substances to enhance their effectiveness. Such drugs might prevent the ejaculate from liquefying (thereby trapping the sperm), alter the physical properties of the cervical mucus to delay or prevent sperm penetration, or inhibit the chemical reactions when a sperm unites with the egg. But all these substances are in the earliest stages of development.

Techniques to Block the Fallopian Tubes

The surgical techniques of tubal ligation — in which a portion of the fallopian tube is looped, tied off, cut, and electrocoagulated — has become a more common contraceptive technique because it no longer requires major surgery. But because tubal ligation generally sterilizes irreversibly, new methods to provide a reversible sterilization procedure are being explored.

The *tantalum clip* was the first potentially reversible occlusive device tested, but it had a high failure rate (over 10 percent in some studies). The *spring-loaded clip* consists of two plastic-toothed jaws held in place by a gold-plated stainless-steel spring. Such mechanical devices generally lead to less postoperative pain and avoid any complications of electrocoagulation after tubal ligation. Additionally, fewer menstrual problems are found in women sterilized with these devices. However, other potential risks, such as internal hemorrhage, hysterectomy, ectopic pregnancy (in which the fertilized egg implants outside the uterus), and spontaneous abortion after removal of the clip, have not been fully investigated. And the success rate with which fertility is restored after these devices are removed is still in question.

New ways of blocking the fallopian tubes without surgery are also being sought. In *hysteroscopies*, fiber optics are inserted through the female reproductive tract to gain access to the tubes; electrocoagulation of the fallopian tubes has been tried with this approach but was abandoned when complications arose. Alternatively, *chemicals* or devices to occlude the tubes can be deposited at their junction with the uterus. Chemicals such as silver nitrate, tissue adhesives, liquid plastics, and ethanol formaline have been tested so far, but it has been difficult to deliver liquids into the fallopian tubes without spillover that damages the uterus or abdominal cavity. Moreover, all such chemicals seal the tubes irreversibly.

At least one device to *plug* the junction between the uterus and the fallopian tubes has undergone some testing. Made of silicone or polyethylene with folded spines, it can be transported through the cervix to the uterus with a carrier. When the carrier is removed, the spines spring into place and keep the plug in place by penetrating the adjacent muscle tissue. In tests on baboons, the plug was 100 percent effective in preventing pregnancy; after removal, fertility returned to more than 60 percent of the animals.

Barrier Techniques for Women

Barrier methods grew in appeal during the 1970s, prompted by increased concern over the risks of pharmaceutical and surgical contraceptives. As a result, more effective and convenient methods than the diaphragm and condom are now being developed.

Only modest funding is now being directed toward male contraception, but there are good indications that men are increasingly willing to accept responsibility.

Intravaginal Collagen Sponge. This new barrier method appears to offer significant advantages over previous ones. Because the acidity of the vagina eventually immobilizes sperm that remain there, a sponge (made of proteins reconstituted from cowskin) is impregnated with a salt solution buffered to the inhospitable environment of the vagina (pH 4.5 to 5.5). The sponge is then placed over the cervix, which ordinarily is not as acidic as the vagina and does not immobilize sperm. Sperm approaching the passageway to the uterus are then slowed by the barrier long enough to be immobilized. So far, tests have indicated that 80 to 85 percent of sperm are immobilized at the cervix by this method.

The sponge can be inserted with an applicator and removed with an attached tape. It can then be washed and retreated with the simple buffered salt solution. Because the buffered solution is very stable (unlike the diaphragm's spermicidal jellies, which lose potency within hours), the sponge can be inserted long before intercourse. The sponge can also be left in place and maintain its efficacy for days. But offensive odors can sometimes develop, limiting the method's appeal. A search for variations on the salt solution to reduce odors is therefore currently underway.

A strong advantage of the collagen sponge is that it does not have to be fitted over the cervix with as much care as the diaphragm, but slippage does occur in about 2 to 3 percent of women. Moreover, the method leaves some sperm mobile, and the failure rate is not yet known. The current strategy for reducing these problems is to use it in conjunction with spermicidal jellies.

A different approach from the one-size-fits-all collagen sponge is a *customized cervical cap*. A molded impression of the user's cervix is made using alginate, and a plastic cap is then cast in the mold. The resulting cap exactly fits the cervix and adheres, like a contact lens, by surface tension. Such a fit guarantees very low pressure on underlying soft tissues, so the cap can be left in place for long periods of time (a one-way valve in the cap permits uterine discharges to pass through). A few women have already worn cervical caps for two years and more, but their efficacy has not been systematically tested. The major caveat in using this barrier device is that its position must be periodically checked: any slippage increases the chance of pregnancy.

Better Rhythm Methods

This very old approach to contraception — detecting (or attempting to detect) when a woman is about to ovulate so that she can avoid sexual intercourse during the precise days of each month that she can become pregnant — is the object of renewed interest. Basal body temperature is not a sufficiently precise indicator, and methods are being sought to predict ovulation with enough accuracy to minimize periods of sexual abstinence. The Billings Ovulation Method, for example, enables women willing to take routine samples of their cervical mucus to recognize marked changes in its quality and quantity around the time of ovulation: the mucus changes from thick and viscous to thin and fluid. This method entails almost no risk but illustrates the critical need for user education and support systems in effective use of low-risk contraceptive methods. Other ways to detect the fertile period, now in the early stages of research, would enable a woman to chemically check her urine for the excretion of ovulatory hormones (proteins or steroids) with a simple kit.

Contraceptives for Men

The widespread use of the condom, and more recently the rise in the number of vasectomies, indicate that men are increasingly willing to accept responsibility for contraception. There is research into new condoms that would dissolve rapidly enough in the vagina to effectively release spermicide. And there have been attempts to develop valves that could be surgically inserted in the vas deferens (tubes carrying sperm from the testes) that could be opened or closed manually — essentially providing the capability to turn fertility on or off. However, there is little indication that these improvements on old methods are imminent. Furthermore, only modest funding is being directed toward new contraceptive methods for men, and thus the pace of development is far slower than for women. Nevertheless, certain research leads do show promise.

Gossypol, the Male Pill. Gossypol was discovered after the Chinese Academy of Sciences sent a team to Hopei Province in 1969 to investigate the outbreak of a disease characterized by fever, general malaise, and burning sensations. Their investigations led to the identification of cottonseed oil in the daily diet as

the agent that affected the cardiac muscles and reproductive organs, resulting in infertility. Although cottonseed oil had been a food staple for generations without any sign of associated disease, modernization of its production removed a boiling step that apparently had been inactivating the disease-causing entity. In 1971, experiments on rats showed that gossypol — first isolated from cottonseeds in 1899 in Germany — was the substance responsible for the reported infertility.

At contraceptive doses, gossypol has not yet been reported to produce toxicological side effects. Infertility (judged by semen analysis) is achieved within two months of daily pill-taking. This implies that gossypol works by inhibiting male sperm production, since it takes two months to deplete a man's sperm reserve. The dose to maintain infertility thereafter is only one-fourth the starting dose. After discontinuation of gossypol treatment, sperm production is gradually restored, and within three months both the physical appearance and the number of sperm appear to be normal. By now more than 4,000 Chinese men have been on gossypol for more than six months, over 2,000 for two years, and some for as long as four years. Offspring of those discontinuing gossypol were reported "normal in every respect," but the effects, if any, from long-term contraceptive doses are still unknown. However, men were generally reported "not too enthusiastic to take the pill."

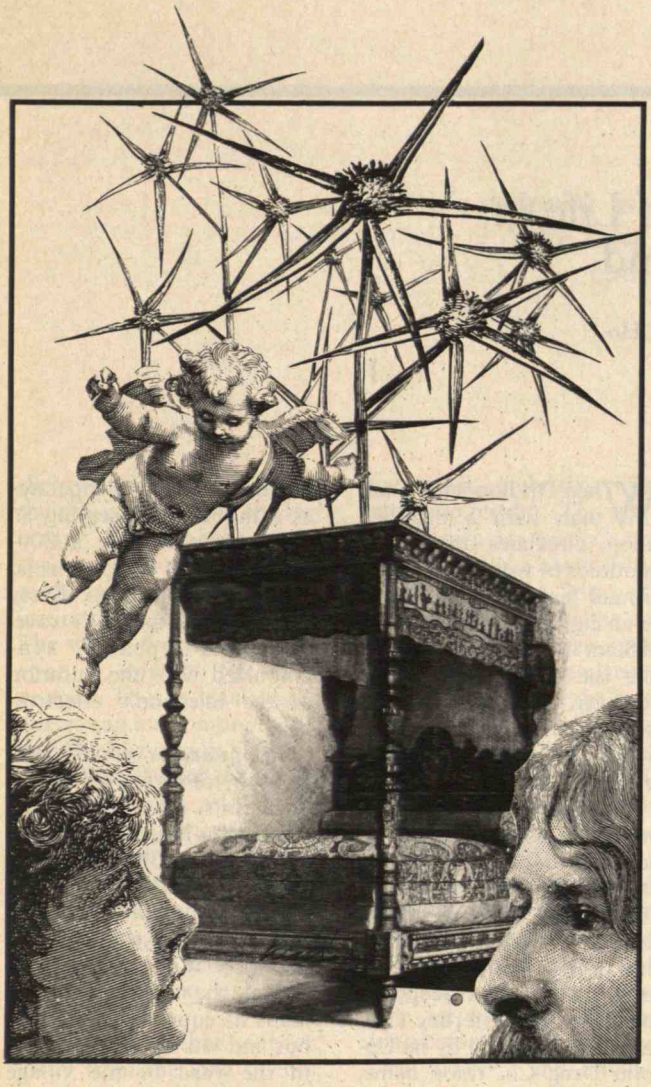
Alpha-Chlorohydrin. The sperm that leave the testes are immature and incapable of motion or fertilization, but they gain these capabilities before they are ejaculated. The genetic material of maturing sperm is not as susceptible to modification by chemical agents as testicular sperm; therefore, contraceptives inhibiting sperm maturation should pose less genetic risk. One such compound, alpha-chlorohydrin, has been investigated. While the compound was nontoxic at the low doses effective for contraception in animals, it was lethal at doses not considerably higher. A chemical closely related to alpha-chlorohydrin and used as a pesticide — DBCP (1,2-dibromo-3-chloropropane) — was recently found to cause sterility in workers in plants where DBCP was manufactured. Such evidence of (unintended and involuntary) contraceptive effect is not unlike the evidence leading to the development of gossypol as a male contraceptive in China, and is indicative of the thin line between health and disease with contraceptive drugs. It has been estimated that to produce chemical analogs less risky than alpha-chlorohydrin (or DBCP) and develop a widely distributed product for men would require 12 to 18 years and cost at least 30 million dollars. Although such a sum is impressive, the drug industry spent 100 million dollars between 1965 and 1969 to develop the Pill.

Sex-Steroid Hormones. Just as egg production in women is dependent on female hormones, sperm production in men is dependent on androgenic hormones produced by the testes. Men could potentially utilize androgens, estrogens, and/or progestins, therefore, to inhibit sperm production. These sex steroids can all act on the brain and pituitary in men to decrease gonadotropic hormones and inhibit sperm production.

The most feasible steroid regime currently being tested combines a modified androgen such as Danazol with another modified androgen (testosterone enanthate) to maintain libido. An effective treatment for suppression of sperm count is Danazol taken in a daily oral pill combined with a once-a-month intramuscular injection of testosterone enanthate. The sperm count returns to normal levels after cessation of treatment, but side effects include acne, weight gain, acceleration of prostatic hypertrophy, and metabolic and cardiovascular complications.

A serious long-term concern with such treatment is that sperm are more susceptible to genetic damage by chemicals than eggs because the cells in the testes from which sperm develop persist throughout life. Thus, any agent causing genetic damage in one such cell can be transmitted to the continuously evolving sperm. In females, egg cells are already sufficiently developed by birth that they receive no new genetic material from supporting cells and are therefore not as susceptible to perpetual genetic damage. However, the scale of clinical trials to date has been too modest to determine whether genetic damage to sperm actually occurs.

Inhibin Analogs. The testes also secrete a hormone called inhibin that inhibits spermatogenesis (a fact long suspected but not actually demonstrated until 1977). Inhibin does not have the metabolic or cardiovascular side effects of the sex steroids, but it is yet to be shown that inhibin does not lower testosterone production and impair libido. If a male contraceptive approach is to be based on inhibin, recombinant DNA techniques will undoubtedly be re-



quired to synthesize it in quantities large enough to make it available at reasonable cost.

Choosing Among Risks

Obviously, many innovative contraceptive methods are now under consideration. But decisions on research-and-development funding will determine which techniques are likely to be pursued long enough to be marketed, and human values play a large role in determining these decisions. The research-and-development process took only 4 to 5 years for oral contraceptives, but similar processes for new contraceptives will now take 10 to 20 years. The costs of preliminary testing to satisfy regulations of the FDA, like those of everything else, have grown tremendously.

There are conflicting views on how to allocate the available, and limited, funds. On one hand, advocates of decreased population growth generally favor pharmaceutical or surgical methods. These advocates' aim is to provide new contraceptives that are highly effective, easily distributed, widely acceptable, and continuously used because of their convenience and lack of bothersome side effects. But they point out that under current conditions for FDA approval, the chances are small that drug companies will reap sufficient profits before their patents expire. Therefore, they argue, governments and international organizations ought to provide further incentives for new contraceptives — by reducing regulations on testing, providing economic assistance to research and development, or both.

On the other hand, the women's and consumers' movements generally emphasize methods that present fewer health risks — even if they are less effective, less easily distributed, and less convenient to use. The drawbacks and inconvenience of safer techniques can be overcome, they maintain, by a larger commitment to user education (with the added benefit of users taking care of themselves). These groups support the development of contraceptive drugs and devices as long as their attendant health risks are thoroughly investigated and publicized. But they request that support systems such as self-help groups also be financed to develop the human dimensions of contraception along with the technological. Such "software" is very costly in terms of time, money, and personnel but it is essential if human dignity is to be maintained.

Consider, for example, the current research into prostaglandins, which offer a large degree of "user control." To those interested in contraceptives for reducing overpopulation, user control is very important because it reduces the need for medical personnel — sorely lacking in many developing countries. In addition, user control increases the likelihood of wide distribution. To the women's health movement, user control is also valued: the woman herself is administering the agent that affects her body. It represents her decision and involvement, and it avoids "medicalization" of the termination of her pregnancy (which would be a transfer of much of the decision making to a system she cannot control). On this aspect, both "sides" agree.

But the safety issue with prostaglandins is another matter. To those in population-control programs

Continued on p. 62

The Facts of Life in Thailand

by Minfong Ho



A Thai hilltribe woman gets her shot of Depo-Provera. "What could be easier?" a nurse asks. "IUDs require training, and the other things — condoms, pills, and diaphragms, well . . ." she shrugs, "you can't expect these people to use them properly."

When Dr. Boonchu, a tall man with a dignified stoop, circulates among the hundreds of women thronged around him, he could almost be an eighteenth-century king of Siam in a royal harem. Unlike the old Siamese kings, however, Dr. Boonchu's role is not to impregnate these women but to make them infertile.

Dr. Boonchu works for a project in northern Thailand partially funded by the International Planned Parenthood Federation. Since its inception over twelve years ago, this project has injected the long-acting contraceptive, medroxy progesterone acetate (better known by its Upjohn Drug Co. trade name, Depo-Provera), into tens of thousands of Thai women, most of them illiterate villagers. In the last 15 years, Depo-Provera has been used as a contraceptive by an estimated five million women in over 80 — mostly Third-World — countries.

This particular project in northern Thailand operates as a mobile unit, serving an area within roughly a 200-mile radius of the provincial capital of Chiengmai. Every three months, the unit's travel circuit is repeated, synchronized with the duration of the injection's effectiveness.

The project is very efficient, as I saw for myself on several occasions. Every day the project bus heads for a village where some 300 to 1,500 women are gathered, waiting. Some have walked for four hours since dawn to come to the spot. Within minutes of arrival, the medical team unloads its equipment from the bus and sets up shop, usually in the yard of the village headman's house. The team consists of an administrative secretary with a box of cards, three nurses to give the Depo-Provera injections, a fourth to interview new recipients, and the doctor — the only male in the group — supervising it all.

The women are quickly separated into two groups, those who have had Depo-Provera shots before and a much smaller group of first-time patients. The first group, already familiar with the routine, lines up expectantly. "Left arms this time," a nurse calls out. And obediently, the women roll up the sleeves of worn workshirts, holding

"It's different for us," one nurse explains. "We have a choice of other contraceptives."

their medical record cards in the other hand. After the secretary cross-checks these cards, the women shuffle on to the next table, get their injections, and then walk away. The whole process takes less than a minute for each woman. Thus, a team of five nurses can inject more than a thousand women in a normal workday. "What could be easier?" a nurse asks. "IUDs [intrauterine devices] require training and a much longer time to insert, and the other things — condoms, pills, and diaphragms, well . . ." she shrugs, "you can't expect these people to use them properly."

Off in another corner, away from the long queues, another nurse interviews the new recipients one-by-one, getting a basic medical history. After a while, their answers sound almost like a litany: "Five children, two dead"; "nine children, three dead"; "six children, one dead." The infant mortality rate in Thailand has declined in recent years. But in the pockets of less-developed areas, and especially in the mountainous regions from which the nomadic hilltribe women come, the "IMR" can still be as high as 40 percent.

Those women with fewer than two children are turned away with a brief explanation that the injections, when discontinued, might delay their return to fertility. The rest of the women are hustled into a semicircle for a short lecture on Depo-Provera. Most of it concerns the cost of the contraceptive, its three-month cycle, and its effectiveness. Little is said about the possible side effects — only weight gain, hair loss, and skin depigmentation are mentioned in passing. What about the possibility of cervical, uterine, or breast cancer, I ask the nurse. Does she ever mention that? She lifts one eyebrow. "Cervical cancer? Most of these women will die from malaria, cholera, dysentery, or even in childbirth long before they may get cervical cancer." She smiles at me before turning back to her injections. "This is not America, you know."

I know. I have seen hilltribe women nursing infants while their grandchildren tug at their skirts. I have seen women in their forties look twenty years older, with as many as 20 pregnancies behind them. I have seen Cambodian refugee women so malnourished that they were amenorrhic (had ceased to menstruate) or who would have frequent miscarriages if they did get pregnant. Yes, this is not America, and therefore American medical standards cannot be applied.

There is a logic to this kind of double standard that reflects the different social realities in the developed countries and the Third World. Thailand is relatively prosperous compared with its Southeast Asian neighbors, but the average life expectancy there is still below 50 years. The physician-patient ratio is still low, and infectious diseases — not cancer — are still the major cause of death by far. In this context, it is easy to understand why a contraceptive such as Depo-Provera might be considered the ideal choice — not necessarily by the recipients but by those with the decision-making power to administer it. Depo-Provera is cost-competitive, easy to mete out, and requires no additional monitoring.

There are, however, a number of more immediate potential side effects, with symptoms easier to observe, than cancer. The most important is Depo-Provera's possible immunosuppressive effect: an Upjohn study, for example, reported that dogs treated with the drug exhibited "lower host resistance to infection." In Third-World countries, where mortality from infectious diseases remains high, the possible alteration of women's immune responses has obvious implications.

Other suspected side effects include *infant* vulnerability (Depo-Provera is transmitted through the breast milk since, unlike some other contraceptives, it does not tend to inhibit lactation), diabetic stress, and retarded bone formation.

If these and other possible side effects are considered, it is not necessarily evident to an informed individual that the benefits of using Depo-Provera outweigh the risks.

Of the five nurses in the Chiengmai Depo-Provera unit, four are married and on birth control. None of them use Depo-Provera. "It's different for us," one explains. "We have a choice of other contraceptives."

Minfong Ho is a former economics reporter for Singapore's daily newspaper, Straits Times. *She has taught journalism at the University of Chiengmai in Thailand and will soon become the editor of* Asia 2000, *a new magazine on technological developments in the Far East. Until recently, Ms. Ho worked as a public health nutritionist with Cambodian refugees.* □

and the drug industry, the main question is: "What risks are *acceptable* to women in order that the product be used?" The question for advocates in the women's health movement is: "Would a woman choose this method if safer alternatives were available for her to control and use at home?"

The differences between these two groups of advocates — that will ultimately affect the allocation of funds — boil down to the perception of social welfare: Does the greatest good derive from an anticipated decrease in population growth or from increased involvement of women and men in controlling their own reproduction?

Whatever the new contraceptives, we can only demand that they arrive with clear information on effectiveness and potential risks. In this way, all potential users will have the freedom to judge the acceptability of risks for themselves.

Suggested Reading

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Lowrance, William W., *Of Acceptable Risk: Science and the Determination of Risk*. Los Altos, Calif.: Kaufman, 1976.

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Carol C. Korenbrot, a reproductive endocrinologist, received her Ph.D. from Duke University. She is on the clinical faculty of the University of California School of Medicine at San Francisco, where she does research on health technology assessment in obstetrics and gynecology. Dr. Korenbrot's investigations into the roles of sex-steroid hormones, and her interest in bridging the gaps among various disciplines, has led to frequent interdisciplinary collaborations. She was coorganizer of a national conference on Contraceptive Hormones and Human Welfare held at the University of California at Berkeley in April 1977.

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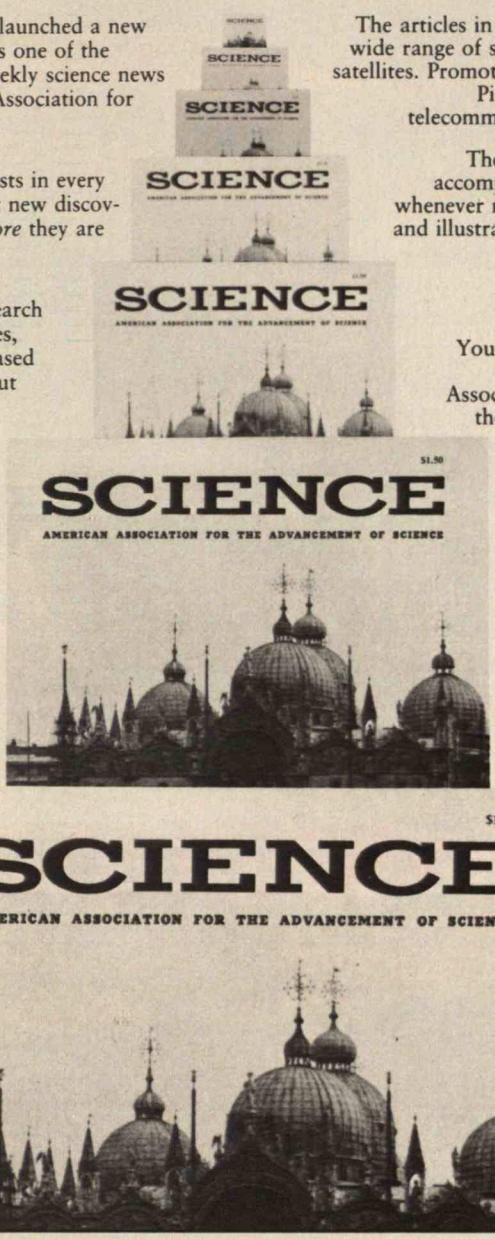
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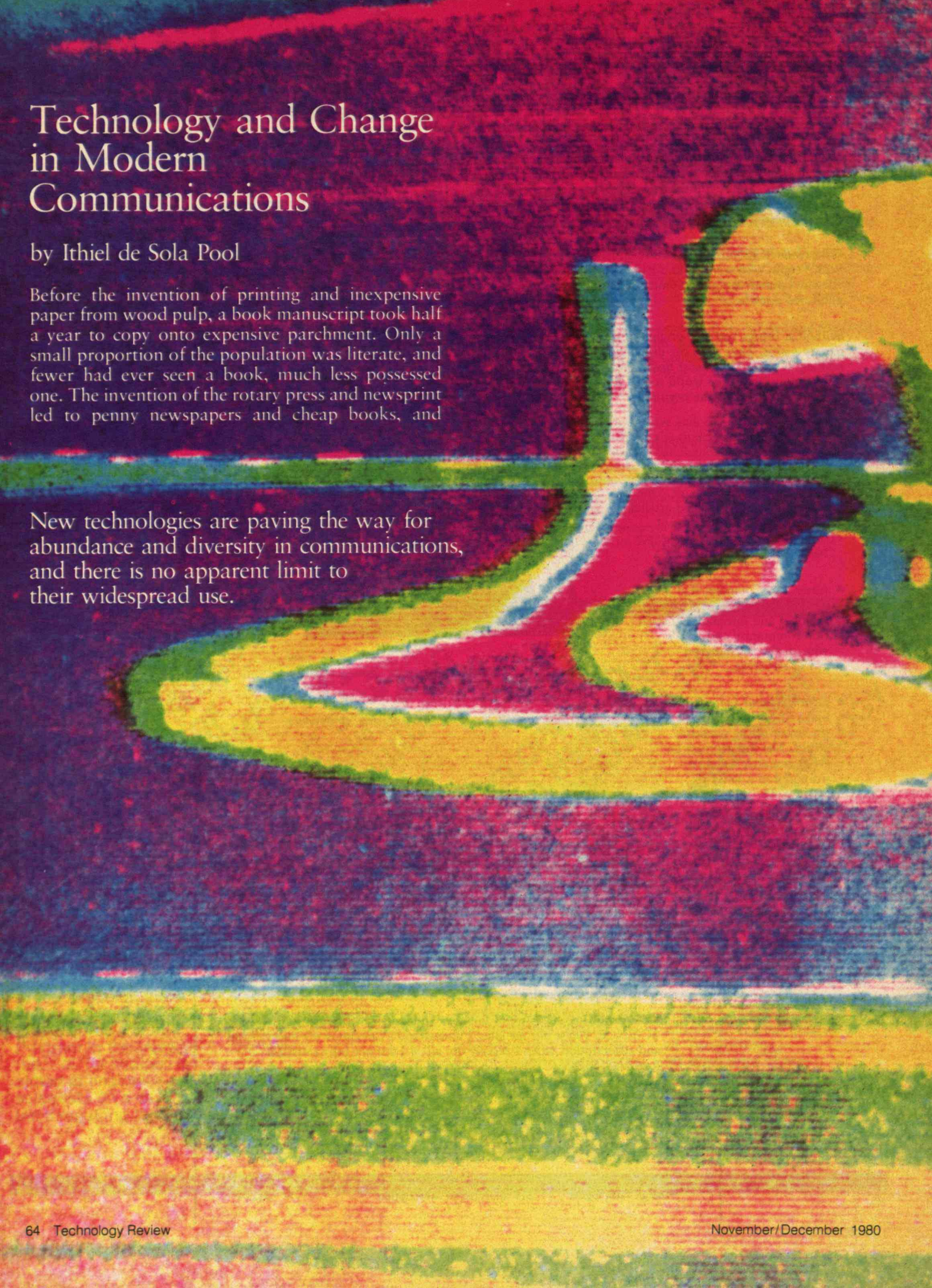
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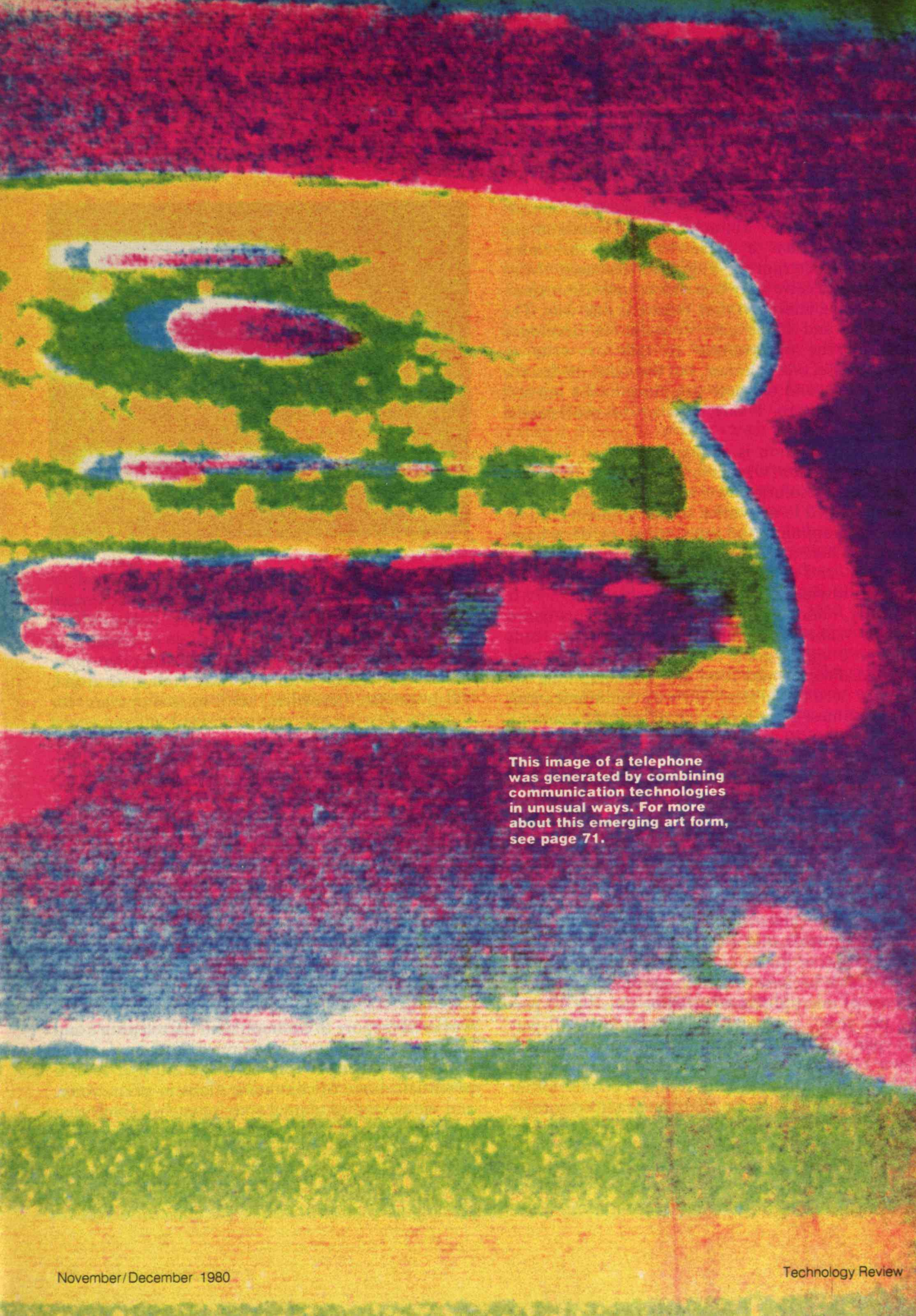
Technology and Change in Modern Communications

by Ithiel de Sola Pool

Before the invention of printing and inexpensive paper from wood pulp, a book manuscript took half a year to copy onto expensive parchment. Only a small proportion of the population was literate, and fewer had ever seen a book, much less possessed one. The invention of the rotary press and newsprint led to penny newspapers and cheap books, and

New technologies are paving the way for abundance and diversity in communications, and there is no apparent limit to their widespread use.





This image of a telephone was generated by combining communication technologies in unusual ways. For more about this emerging art form, see page 71.

By the year 2000, the cost of a computerized home communications system should be approximately equivalent to that of an automobile.

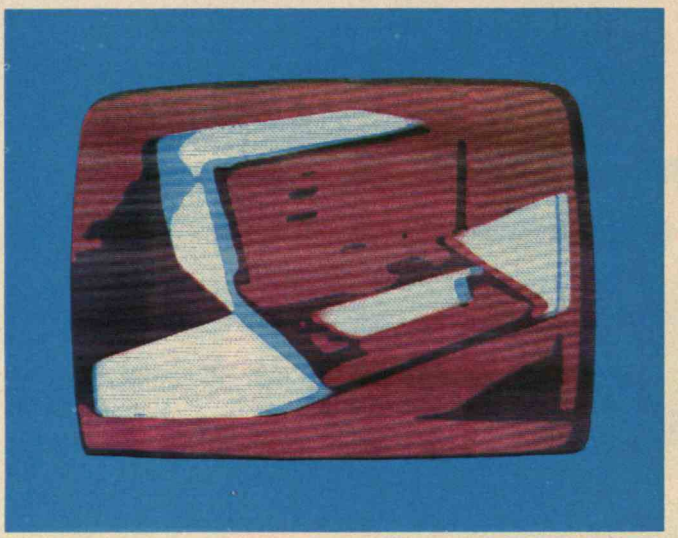
newer media, such as radio broadcasting, are sometimes even cheaper. Yet achieving and maintaining literacy still costs a great deal, and the radio-frequency spectrum is a limited resource. Most people can receive only one or two television channels, and the television they receive is one-way. The telephone and mails give everyone in developed countries the opportunity to talk or write to everyone else, one at a time, but the video media, the mass media, and the new computer media are still available only to a tiny number of professional communicators.

But that situation is changing. We can visualize (as science-fiction writers often do) future homes having high-resolution two-way video and personal computers tied to networks, so that residents can receive programming and gain access to data bases from anywhere in the world, send out messages electronically, and engage in two-way video conversations worldwide. Cost is the only obstacle.

Clearly, nations will make the investments necessary to realize communications abundance only after more urgent goals of development have been achieved. People need food and medicine long before they need broadband two-way communications in their homes. Therefore, such advanced communications will not come soon, even in the richest societies.

A middle-class home in an advanced country typically has telephone, radio receiver, phonograph or tape player, and television receiver, requiring a capital investment of about $1,500. A standard future computerized home system may include a videophone with conference capability, an intelligent computer and electronic-mail terminal, multichannel, two-way cable (optical-fibre) television with feedback controls, and a video recorder and player.

This vision of future communications abundance is practicable because of the extraordinary decline in the cost of microprocessors (falling now by 22 percent per year), computer memories (down 40 percent per year), and communication equipment (down 11 percent per year). By 2000, the cost of a computerized home system should be only about twice that of the present telephone-radio-recorder-television system — an investment in constant dollars approximately equivalent to that for an automobile. This is well within the realm of possibility for the population of a developed economy; it will be the challenge of the twenty-first century to make



such communications abundance truly universal.

What would the availability of such advanced communication facilities mean for industrialized countries, for an ever-widening circle of developing nations, and eventually for all? Equipping every home and office with two-way video receivers, videocameras, recorders, and minicomputers for word processing and electronic mail, all connected to a fiber-optic digital broadband network, has very remarkable implications.

Communications without Bounds

The usual technical condition for exercising control over communication is its scarcity. A censorship or copyright system can control printing because there are relatively few presses, with only a few publishers in control. Controlling electrostatic copiers, typewritten sheets, telephone calls, and conversations is much more difficult, for they involve millions of individual acts throughout the world.

In this respect, the newer communications networks have more in common with the telephone and electrostatic copying than printing. Each node — or point of contact between network and user — is a potential source of communications in print, voice, and video, and of many copies of each. Monitoring the flow from each node would present massive difficulties. Pictures, words, music, and data flow are interleaved as indistinguishable electronic bits in a broadband digital network like that gradually replacing the analog networks. The code for decipher-

Current trends favor a flow in all directions of ever more messages from ever more producers.

ing them will be stored in tiny, inexpensive, solid-state chips. The sender and receiver will share a pair of such encryption chips, and no one without an identical chip will be able to tell what the bit stream represents.

In addition to receiving and originating, each node will also be able to edit and retransmit. Thus, a person retrieving material from an information base can modify it and relay it to others. One can visualize people circulating constantly changing comments in a manner resembling conversation more than a letter to the editor in the present one-way media.

So current trends favor a growing free flow of messages in all directions, with more producers of messages than in the present era of mass communications. The fluid network that makes this possible will have no natural barriers or frontiers. An indecipherable broadband stream of digital data on a network, in which costs are insensitive to distance, will not lend itself to national segmentation.

Declining costs will also spur the volume of international communications. Indeed, this is already happening: the costs of international telephone and telex are falling and their volumes burgeoning. Yet rates have not fallen commensurate with costs; in most countries international traffic is the carriers' most profitable business. As rates fall further and become even less sensitive to distance, we can expect businesses, social institutions, and individuals to expand their remote contacts and relationships.

Information Equalization

One result of easy international communication is access to information for institutions everywhere, regardless of location. Information activities have been geographically centralized at institutions such as the British Library, the Library of Congress, and the Moscow State Library. Banking and finance, too, gravitated to a few centers — London, New York, and Zurich — because communication and access to information are the heart of such businesses. The world's great research and art centers are similarly limited to a few dozen locations.

Communications abundance, with costs insensitive to distance, will free institutions and people to locate such activities in whatever places are most convenient. Indeed, this is already happening. For example, recently an American company, specializing in processing inquiries into U.S. government files under the American Freedom of Information Act, located its principal analysis operations in Scotland, where wages for people qualified to read through the masses of files are lower than in the U.S. The low cost and high efficiency of international information transfer made this choice possible. A substantial number of American businesses have moved their corporate headquarters out of New York City. Financial activities on a large scale are now found in places such as the Bahamas and Cayman Islands because it is easy to keep in touch with the rest of the world.

Unlike bankers and large corporations, scholars and intellectuals do not yet enjoy such ease of access to their resources from remote locations; costs have not yet fallen to the point where individual professionals can afford modern on-line information systems. But the trend is clear: in most developed countries — and in some underdeveloped ones — researchers are now able to connect their terminals through the phone system to computerized data bases regardless of location. As computerized storage becomes the prevalent mode for filing information, and as costs decline, such systems will give scholars everywhere access to data now enjoyed only by their colleagues at the principal research centers.

Indeed, scholars at remote locations may enjoy advantages over their centrally located colleagues. Data preparation, being labor-intensive, is not an activity with large economies of scale; but data distribution (as by libraries) has enjoyed such economies. Easy network access changes this fact: we can expect many specialized institutions, with competitive advantages because of their locations, to become data suppliers to persons elsewhere. Thus, a world with a good communications system is likely to have more dispersed centers of activity than today: it will be a multipolar world.

Increased Diversity of Communications

The lowered cost of communications will lead to new diversity of content, at least in voice and text communication; diversity will be harder to achieve in video because it uses so much bandwidth and programming is so expensive. The problems with video are substantial, but so are the opportunities. One can put about 1,000 voice channels and

perhaps 25,000 text channels in the radio band required for one television broadcast. Depending on the size of the country or language area, conventional television broadcasting methods can typically give viewers anywhere from three to eight channels. Direct satellite broadcasting could add a few channels, and videotape or videodisc players would permit people to borrow performances out of large libraries, as with books. But if many channels are added, the signals must be delivered in an enclosed transmission medium rather than over the air. Coaxial cables, depending on their size, can carry from 12 to perhaps 50 television channels to each subscriber. Scores or even hundreds of channels might be carried by reasonably sized bundles of optical fibres.

Can enough programs be produced to fill this growing capacity? For programming in its present format, the answer is clearly no. But there are many other uses for video bandwidth besides slick television shows or movies. The additional channels should encourage innovative uses of television for which there is now no room. Only a small number of people may be interested in unrehearsed material that does not meet professional entertainment standards, but these groups exist. Other examples of such programming include discussions of local problems, education, local sports events, legislative activities, and amateur dramatic or musical productions. Such uses are uneconomical in a television of scarcity but not in a television of abundance; furthermore, the cost of nonprofessional production is falling because of cheaper recording and editing equipment as well as cheaper bandwidth.

In contrast to video, there is far greater opportunity for realizing communications abundance in radio and print. New techniques such as time division multiplexing now make possible much more efficient use of the radio spectrum; indeed, 1,000 radio stations could serve every city of the United States. In addition, there is the possibility of transmitting in "enclosed" media such as multiplexed optical fibers. There is, of course, a trade-off: adding radio channels requires more expensive receiving equipment.

The growth of diversity in print media is sustained by two technologies that allow economical production of small editions: electrostatic copying and computer printing. Electrostatic copying has enabled some publishers to turn to on-demand printing: rather than warehousing thousands of copies, publishers run off copies as orders come in. No book need ever be out of print.

Computer printing exists in many forms, ranging from the automated typesetting now widely used in newspapers to the individual printout from an information retrieval inquiry. Since all news is now available from computerized typesetting machines fed by the world's news services, it is — in principle — possible for any individual subscriber to have access to the news. Such users could instruct their computer to excerpt only items of interest from the day's news through a series of key words.

This example illustrates both the technical possibilities and the practical limits. Actually, newspaper service based on key words would be very unsatisfactory — many important events involve topics in which interest cannot be anticipated. The newspaper of the future will undoubtedly involve a compromise betweeen the mass medium of today and the purely responsive on-line information service. Yet the compromise, whatever its form, will be a large move in the direction of greater diversity.

The Growing Information Sector

A corollary of increased diversity is increased quantity. Even a superficial review of the annual UNESCO volumes reporting such items as world newspaper circulation, book publication, and radio broadcasting will show that there is an explosive growth in communications output. While much of that growth represents diffusion of existing materials, the generation of new materials continues apace. In Japan, a census shows that the production of words in all media has been increasing at the rate of about 10 percent a year. Given the limits of human attention, however, consumption of words has been growing by only 3 percent a year. Although "information overload" is very real, the Japanese data also illustrate increased diversity: if the number of words produced grows faster than the number consumed, the average audience for each word must be decreasing. New technologies of data management allow us to deal with ever larger stocks of data, even if we cannot directly scan all the contents.

The growing production and consumption of information is also demonstrated by figures compiled by Marc Porat for the U.S. Department of Commerce: in 1900, 13 percent of the U.S. labor force was in information occupations; by 1950, 31 per-

Communications Technology for the Developing Countries

What do developments at the leading edge of communications technology mean for newly developing nations?

The less-developed countries require large injections of information in the form of technology transfer. But the development of computer-based publishing in the industrial nations could worsen the position of the poor nations unless they too have telecommunications resources. Without a successful effort to bridge the chasm that separates the technical facilities in developed countries from those in the rest of the world, the developing nations will be denied access to the new information resources they so desperately need. In contrast, exploitation of the new, low-cost global data networks could give developing nations remote access to the best information sources, thus rapidly narrowing the information gap.

One common reaction in the developing nations to suggestions for access to international data is fear of dependence. But it can be effectively argued that lack of trained workers and access to modern facilities is a principal barrier to entering the modern world. Instead of increasing these nations' dependence, better communications assuring better access to advanced knowledge will permit developing countries to more quickly acquire the skills to become independent.

It is often proposed that developing countries, lacking both money and skills, cannot be expected to make much use of modern information retrieval systems or computer communication. Developing countries must learn to walk, it is said, before they learn to run — they should use labor-intensive processes such as hand-set newspapers to utilize surplus unemployed labor instead of capital-intensive ones such as computer composition that absorb scarce capital. They should rely on traditional communicators — folksingers, dramatists, storytellers, and priests — who have credibility and relevance in the culture that no imported, impersonal form can have.

Despite their merit, these arguments do not prove that high-technology communications are inappropriate for developing countries. Suppose that someone had opposed the new technology of transistor radios for developing countries, urging that conventional tube radios were a more appropriate technology. Transistor radios are cheaper, more reliable, easier to produce indigenously, and portable, and they use less current. They are what developing countries need, and their use has made radio the developing world's most pervasive communications medium.

Not all communications media should be adopted identically in the industrial and the developing world. Television has been tested as a village facility in India. In China, broadcasting was first done mostly through wired loudspeakers instead of by conventional radio.

Certain characteristics are necessary for a telecommunications system to serve effectively in a developing country: it should be an aid to expression by those persons with credibility in the culture; it should use the language and symbols of the culture; it should be capable of local adaptation; and it should be inexpensive, requiring as little foreign exchange as possible. It should also be reliable, relatively rugged, and simple enough to function without sophisticated maintenance and operating personnel. It must not require an elaborate infrastructure such as a stable source of electric current, nationwide microwave relays or cable networks, and smoothly functioning telephone service. And it must link the underdeveloped region, at will, to all sources of data, not just to those on which it is by custom or political alliances dependent.

These by-no-means-insuperable requirements can be met by high, intermediate, or primitive technologies, just as high, intermediate, and primitive technologies may fail to meet them. What is sometimes denied is how well some of the new technologies —transistors, electronic telephone switching, satellites, and computer data networks — match the requirements of poorer lands. The cliches about high and intermediate technology are far too simplistic.

Though opportunities for using advanced technologies of communication to accelerate development are waiting to be exploited by any developing country, the following four media seem appropriate particularly for countries with large land areas and scattered villages:

☐ *International computer communication* with store-and-forward message switching — the message sits in the transmitting computer until a circuit is available for transmission at any hour of the day or night. The message is then held for its addressee at the receiving terminal. A store-and-forward system utilizing low-cost satellite receivers can bypass telephone facilities where both parties must be at their respective instruments simultaneously (very frustrating if operators take an hour or more to complete the circuit), and can reach remote regions where microwave or cable are not available.

☐ *The transistor radio* —found everywhere. It is the means by which news spreads, government reaches the people, and mass education is accomplished.

☐ *Television* — a community facility that obviously adds to the effectiveness of broadcasting. Though television receivers are too expensive to be owned by many individuals, television used as a community facility can make a significant contribution to the quality of village life. Conventional transmission to the village set is economical in small, densely populated areas. Where the territory is large and populations dispersed, satellite is the appropriate means of dissemination, as demonstrated by Canada in programs to the Arctic and by India in the SITE transmissions.

☐ *Telephone* — another community asset. Delivering telephone service by satellite is often far easier than developing conventional wire systems or microwave networks. A single public telephone call box in a village, though used on the average of only three or four times a day, can change the whole life of the village by providing two-way communication with the nearby market town and district officials. Local nurses or teachers can make requests of superiors and receive instructions; farmers can inquire about the market and learn when to pick up fertilizer they have ordered; money lenders can call to dun their debtors; and with a tape recorder as an accessory, the provincial government can obtain feedback from village discussion groups.—*I.D.P.* ☐

cent of the labor force was in the information sector; by 1960, 42 percent; and by 1970, 46 percent. That is nothing short of a revolution: in a quarter of a century, the labor force involved with information instead of things has gone from one-fourth to one-half of all U.S. workers.

The number of persons in the information sector is approaching the limit — there are simply too many other jobs to be done. Indeed, there is every reason to expect a repetition in the information-processing sector of previous events in the agricultural and industrial sectors. In preindustrial societies, up to 90 percent of the work force was involved in agriculture. Growth in agricultural productivity was a precondition for the development of an industrial labor force (4 percent of the American work force is now able to feed us all). Then, labor-saving technology was developed to cut that large industrial work force. Today the unautomated information sector is the single largest source of employment, and it is therefore now the prime target for improving productivity through automation (*see "The Office of the Future: Information Management for the New Age," by Paul A. Strassmann, December/January 1980, p. 54*).

The computer is the key invention in this new drive toward productivity. For example, in newspaper plants, computers are raising productivity in typesetting and layout, and office automation is proving to be just as important for profitability as assembly-line efficiency.

Quality versus Quantity?

Though the number of jobs in the information sector will not grow much larger and may even decline, information production will continue to grow because of computer-based automation of information processes. This growth in output will inescapably have implications for quality as well as diversity.

In general, diversity is associated with a decline in average quality. The most elaborate and impressive intellectual products — be they newspapers, television shows, or opera performances — require levels of investment possible only for those with a near-monopolistic hold on a market. Great opera companies, symphony orchestras, and even newspapers are typically one to a metropolis, simply because several smaller competing companies cannot produce the same high-level performances; fragmentation of the audience tends to reduce budgets and thus quality.

On the other hand, diversity allows wide participation, with many outlets for creativity. So we confront a dilemma: How shall we choose between a society in which many mediocre performers compete for the public's attention and one in which only a few superb stars perform? What of the probability that out of vigorous artistic experimentation and amateur effort may flower products of great value that would otherwise be lost?

Different societies will make different choices. The point is that the new information technologies that assure us of increasing communications abundance — video recording, multiplexing, electrostatic reproduction, and especially the computer — are making it economically possible to multiply centers of production and encourage many forms of "do-it-yourself" communication. This trend can only shift the balance in communications toward expanded production of mediocre material.

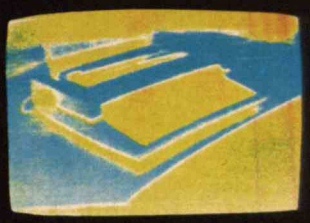
Protecting the Unprotectable

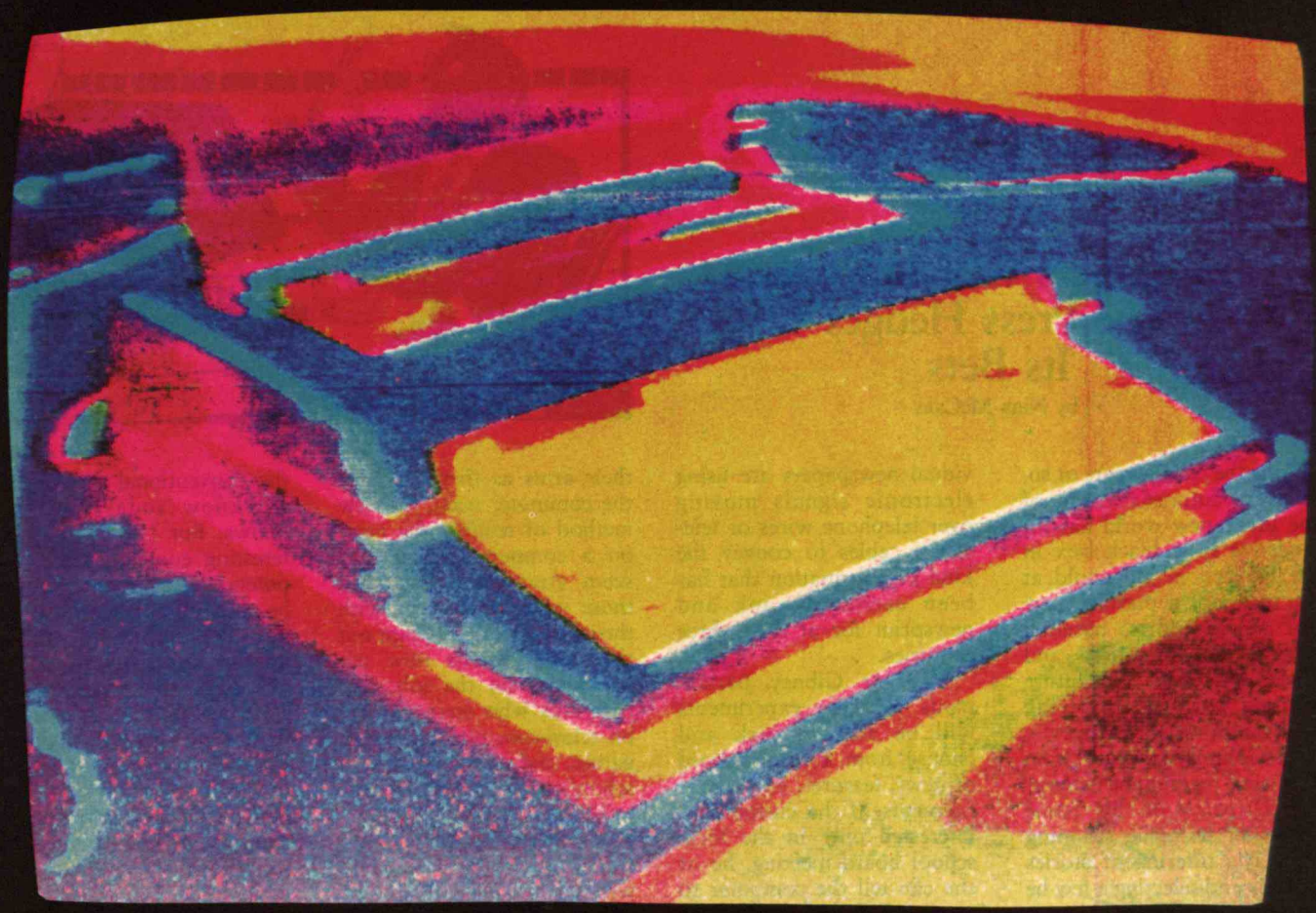
Control of intellectual products becomes more difficult when their production proliferates. Both political and commercial control depend on scarcity and would-be controllers' ability to monitor strategic bottlenecks. For example, anyone who would gain compensation for intellectual products must be able to control the release of those products.

The concept of copyright was a by-product of the printing press. Judges saw no reasonable way of controlling who sang a song or read a text orally, so under common law no copyright could be enforced against them. Only with printing were legible copies made in substantial numbers in a well-defined place. More recently, producers of movies, records, tapes, and computer output have sought — and in various legal systems (for example, the Bern Convention) have won — some copyright protection for these new modes. However, the rights granted are often largely unenforceable. In particular, magnetic tapes, electrostatic copies, and computer output are virtually uncontrollable.

How should societies respond to this changed reality? The creative flow may dry up unless there is appropriate compensation for intellectual products. On the other hand, it can be argued, as the

Continued on p. 75







The prints throughout this article were made by Tom Norton at the M.I.T. Visible Language Workshop; they are the products of a video/color copier system.

A television camera is focused on a subject (in this case, a typewriter) and viewed on a black-and-white television monitor where the image can be modified electronically. Variations of this image, such as positive, negative, size, or line conversion, can be carefully manipulated and selected as "plates" for prints. These printing images are projected into a 3M Color-in-Color machine, where selected colors, synthesized from yellow, magenta, and cyan dyes, are transferred into the corresponding black and grey areas of the original image. When the desired number of colored images has been superimposed, the print can be ejected from the machine. As the entire process is accomplished in minutes, variations of color and graphic composition can be spontaneously and sequentially produced, as shown here.



Newspapers vs. Computers: The Press Hedges Its Bets

by Nina McCain

For the last 25 years or so, every futurist's vision of the brave new world has included a little black box in the living room that would, at the touch of a button, spew out news reports, baseball scores, stock quotations, and casserole recipes. That future is now arriving in living rooms all over the country.

In Columbus, Ohio, John Gibney is reading the *Columbus Dispatch* on his home computer terminal, scanning the day's offering of stories quickly and selecting a few he wants to read in full. Later, the 31-year-old president of a fund-raising company may "chat" with new friends around the country on the computer version of a citizens-band radio. And if "the guys come over for a couple of beers," they may play electronic football or golf or war games.

Mr. Gibney, like thousands of other computer users, is participating in one of three separate experiments designed to test the market for the electronic delivery of information to American homes.

The Associated Press (AP), the Knight-Ridder newspaper chain, Dow Jones and Co., and more than a dozen individual newspapers are using electronic signals moving over telephone wires or television cables to convey the kind of information that has been carried by ink and newsprint for at least three centuries.

Like Mr. Gibney, participants in these experiments will be able to pick and choose from a smorgasbord of news, features, and advertisements. If the customer is interested only in the local school board meeting, he or she can tell the computer to go directly to that story and skip inflation, politics, and the latest revolution.

In some cases, the customer will be able to place orders with advertisers via the computer, using a credit-card number. As the systems become more sophisticated, shoppers will be able to use them to find the best buys on hamburger or house paint and to show the classified listings for sailboats or sofas without wading through houses, autos, and pets.

Market Penetration

For readers who are used to browsing through the paper with their morning cups of coffee or tucking it under their arms as they head for the commuter train, the new method of reading the news on a computer screen may seem strange at first. But those who are familiar with the new technology point out that many adults now use computers on the job, and that kids who were weaned on television, play electronic games, and use computers at school are likely to take easily to the new system.

The print media have decided to test the waters in what is usually called "the home-information revolution," on the theory that if they do not provide the kind of information that has traditionally been their specialty, others will. The question that lurks in the background is: Will the newspaper be replaced by the little black box in the living room?

Most newspaper people don't think it will, but they are hedging their bets.

In announcing the experiment involving the Associated Press and 11 local papers, AP general manager Keith Fuller acknowledged the uncertainties of the new field. "We have no idea where information retrieval will lead in the future," he said. "Whether it will ever replace the conventional media that we know today, no one knows. But I think it is interesting enough, it has the potential, and we all should be aware of it. We want to do the experimentation on the ground floor."

Benjamin Compaine, a staff member at Harvard's Center for Information Policy Research who is a specialist in the new technologies, believes the newspaper will continue in its present form for the foreseeable future while the new systems develop alongside it, much as television developed beside radio. "I would not spend much time worrying about the extent to which newer media are going to take over your turf," Dr. Compaine recently told a meeting of suburban newspaper editors. "In practical terms, there are good economic, marketing, and sociocultural reasons why such services will find only limited penetration in the consumer market in the current decade. "Consumers are going to invest in the new hardware only to the extent they perceive its ability to provide them with information that is different or in some way better than what they now have."



The experiments now underway around the country are designed to find out if there is a market for the new systems. Do people really want newspapers delivered via a computer instead of on their doorsteps, and how much are they willing to pay? What kinds of information will they want? More consumer tips and fewer feature stories? More local news and less national?

Regulation and Control

Beyond the more immediate questions of cost and content are larger issues with far-reaching implications for all of society. Will traditional First Amendment freedom of the press apply to the signals sent over telephone wires or television cables? Who will regulate the new systems?

Already there have been predictions that the Federal Communications Commission, which regulates radio and television, could expand its jurisdiction to include material from newspapers and magazines sent into homes over cables or phone lines. Any move in this direction would certainly be challenged by the print media, which jealously guard their constitutionally guaranteed freedom from government regulation.

Among the groups interested in these questions is, not surprisingly, the American Newspaper Publishers Association (ANPA). The immediate focus of their concern is legislation now before Congress which, the publishers contend, would open the door for the American Telephone and Telegraph Co. to move into the business of producing information as well as carrying it over telephone lines.

In a letter to ANPA members, Katharine Graham, publisher of the *Washington Post* and president of ANPA, warned of the dangers of giving a monopoly like AT&T control over both the collection and distribution of news and information. "The possibility of one giant corporation becoming the information supplier — an increasingly dominant information supplier — to four out of five American households strikes many of us as profoundly troubling," Ms. Graham wrote.

Telephone lines are vital to the new systems since most information will be transmitted over them. Two of three current experiments use phone lines, while the project involving Dow Jones, the *Dallas Morning News*, and its parent corporation, A.H. Belo Corp., will use television cables.

In the AP experiment, phone lines will link the wire service, 11 member papers, the CompuServe Computer Co. in Columbus, Ohio, and home terminals around the country. For an initial charge of $15 to $30 and $5 for each hour of use, customers will have access to selected material from the local papers and the wire service. In fact, they will receive information at the same time that it reaches newspaper offices and television studios.

According to Henry Helbrunn of the AP, the initial customers are expected to be "computer hobbyists . . . They would have the type of home that is gadget-oriented, that has a microwave oven and a big-screen television, that looks to the new technology for ease of living." John Gibney fits that picture perfectly. "I'm a tinker-toy man," he admits cheerfully. Gibney says he finds it much more convenient to scan the paper on his computer than to read it in the usual fashion. He spends from one to three hours a day using the computer and, since it is billed to his company, he doesn't worry about the cost. "When I can't sleep some nights, I read the paper on the computer." The Gibney household does not take a paper and does not miss it. "My wife doesn't use the computer," he says. "She'd rather watch the news on TV."

But William Perry, publisher of the *Middlesex News* (in Framingham, Mass.), thinks that most home users will be interested in specific kinds of information rather than browsing through the paper as Gibney does.

"Unless you're way up on a mountain or caught in a blizzard, I don't think you'd read the whole paper on a computer. There's a cost factor. The system can only transmit 300 words a minute. At 8 cents a minute, it would cost a lot to read a 48-page paper. Let's face it, TV's cheaper."

Nina McCain is a staff writer for the Boston Globe. *This article is adapted from "The New Electronic Newsboy," published in the* Globe *on August 31, 1980. Reprinted by permission.* □

The diamond solitaire.



A rare gift.

One single diamond.
Set simply and elegantly, to sparkle on its own.
The diamond solitaire.
A jewel that becomes more precious with
every passing year.
The gift that makes a rare and beautiful
moment last a lifetime.

A diamond is forever.

The ¾ carat diamond shown is enlarged for detail. DeBeers.

The trend toward communications abundance can only shift the balance toward fairly mediocre material.

Continued from p. 70

common-law judges did, that unenforceable laws are bad laws. For the present, social ingenuity is needed to support knowledge and the arts by new means that do not depend on controlling uncontrollable reproduction.

International Cooperation

The basic assumption of the present international order in the use of the radio spectrum and geostationary orbits is that these are resources for all humankind to share equitably. But in practice — except for Intelsat — these resources have been allocated among nations through an international legal process. As demand increases, this form of sharing may be unsatisfactory; efficient use of the spectrum and satellites will be possible only with cooperative international operations.

For example, it is unreasonable to forecast that every country requiring satellite services will have its own satellites — one for direct broadcasting and one for distribution, for example; this would result in impossible and unnecessary crowding. The alternative is either a giant platform or a cluster of colocated satellites for many transmitters and switching facilities, with efficient multiplexing of the focused transmission beams. This more reasonable path of development will require a transnational management organization such as Intelsat, to which 17 countries have now turned for domestic communication services as a more cost-effective solution.

Breakdown of Telecommunication Monopolies

Postal, telegraph, and telecommunications services enjoy legal monopolies in most countries that technological changes are now rendering obsolete. Today text can be sent by facsimile over telephone lines, and telegraphic-type messages are much more efficiently handled by computer terminals coupled to the telephone system. Indeed, these so-called "electronic-mail" services can be handled over telephone circuits without involving the post office.

There are other new uses of the telephone network. Prestel, organized by the British Post Office, gives users in the British Isles access to almost 200,000 pages of text placed in the system's computer by various providers. For example, users can dial a number on the telephone to have a railroad timetable displayed on their television set. Prestel could also be used to send messages from one subscriber to the television set of another, though that service is not yet offered.

If convergences among monopoly services such as post and telephone were the only issue, mere reorganization of the monopoly would keep the system intact. However, a growing number of ways to transmit messages (in text, voice, and picture) bypass existing networks altogether. Businesses and other institutions can use rooftop antennas to communicate by microwave (if close together) or satellite (if far apart); such a satellite system is being developed in the United States by Satellite Business Systems. Computer networks, even if they lease their lines from the telecommunications monopoly, perform switching functions that in the past were the exclusive prerogative of that monopoly. Local, private exchanges attached to telephone networks are familiar, but those private exchanges have grown into national and international networks of their own. Though they are connected to the main network, they represent complex private extensions.

Responding to these technological changes, the United States is moving away from monopoly in the telecommunications field by permitting competition among the proponents of the various media. Although other nations are reluctant to do this, no nation can be unaffected by its neighbors. If a country fails to provide useful international communications facilities, communications can be sent via countries whose services are more efficient.

If technology is rendering obsolete bureaucratic communications monopolies, international competition also will make those monopolies hard to preserve by legal fiat. We can expect that almost everywhere nations will begin to accept the technical reality of communications abundance and the associated reality that information flow will become less subject to control. For, unlike physical wealth, growth in the availability of communications shows no visible limits.

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Boulding/Continued from page 4

Avoiding and adapting to social catastrophes and extreme positions of social systems is more difficult than adapting to natural catastrophes. The causes of natural catastrophes are perceived as external, so we cannot blame anybody, we merely have to adapt to them. Social catastrophes, however, are the result of poor human decisions. This gets us into accusation and blame, which makes it hard to admit that decisions have been bad and should be changed. We fall into a "sacrifice trap": decisions involve sacrifices, and it is difficult to persuade ourselves that these sacrifices have been in vain. Sacrifices of religion, revolution, and war tend to fall into this category. It was hard for the Aztecs to admit that human sacrifices did not really make the corn grow. It is hard for revolutionaries to admit that the sacrifices they have imposed on others and on themselves have been fruitless. It is very hard for a government to admit that a war that has taken many lives should never have been started.

Indeed, there is something to be said for treating social catastrophes like natural catastrophes. If the American involvement in Vietnam, the unspeakable tragedy of Cambodia, the untenable quandary the Russians have created in Afghanistan, the wave of fundamentalist madness that has engulfed Iran, and the economic decay and political tyranny that overtook Argentina, Uruguay, and Chile had been treated as "social hurricanes," they might have blown themselves out faster and with less human suffering. We did not fight, preach at, or denounce Hurricane Allen, we just adapted to it.

There are times when battening down the hatches, keeping quiet, going underground, or retreating to the hills may be a more effective mode of adaptation to social hurricanes than preaching or fighting. I am enough of a preacher, however, to feel that there are times, especially in social systems, when preaching is effective, when social cloud seeding is possible, when a wise word to the powerful can divert hurricanes of social catastrophe. What is wise and who is powerful, however, is not always easy to discern. What wise word, and to whom, for instance, would have avoided the catastrophes of the First and Second World Wars, the Great Depression, the First Collectivization, the Cultural Revolution, or the Cambodian tragedy? The list is endless, but the search must go on. Sometimes the powerful are guided by the "academic scribblers," as Keynes called them, of the last generation, and sometimes by the scribblers of 1848, or 620, or 100 A.D., or 500 B.C. One is reminded of the deaf Indian in the comic strip whose activity is described by "scribble, scribble."

The two social catastrophes now threatening us are nuclear war and resource exhaustion. The probability of nuclear war has risen alarmingly over the last year or so. I would have put it at less than 1 percent per annum a couple of years ago; today it is at least the rate of inflation.

While walking along the California coast last January I slipped and found myself sliding toward a cliff. What I did was most undignified. I twisted myself around and clawed my way up the bank, arriving at the top messy but safe. The question today is: how do we lose our dignity and scramble to safer places? That is not easy, especially for the powerful. Dignity, perhaps, is the only thing that keeps them from jumping off the cliff themselves, though it also prevents them from thinking about the consequences of their acts.

Resource exhaustion is harder to deal with because it is so remote to ordinary people and decision makers. Who can believe in the energy crisis when it is so easy to fill up one's gas tank and the stores are crowded with merchandise? Here, perhaps, we need more dignity and less scrambling, more sense of stewardship and concern for the future. Oh, well, "scribble, scribble." □

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balanced against manufacturing cost. Unless engineers and scientists from the military-serving sector are retrained and reoriented to the civilian marketplace economy, they will not function effectively there.

With careful planning, such a conversion, now fairly well understood, can be carried out smoothly and effectively. In fact, the Defense Economic Adjustment Act, S.1031 and H.R. 4436 (*see box*), would set up a highly decentralized system for planning such a conversion. This bill awaits action in committee.

Shifting our technological resources back into commercial production is not inconsistent with the nation's security needs. A Boston Study Group report (*The Price of Defense*, New York Times Books, 1979) concluded that we could improve national security *and* reduce the military budget by 40 percent by restructuring our forces (for example, by focusing on submarine-based as opposed to land-based missiles).

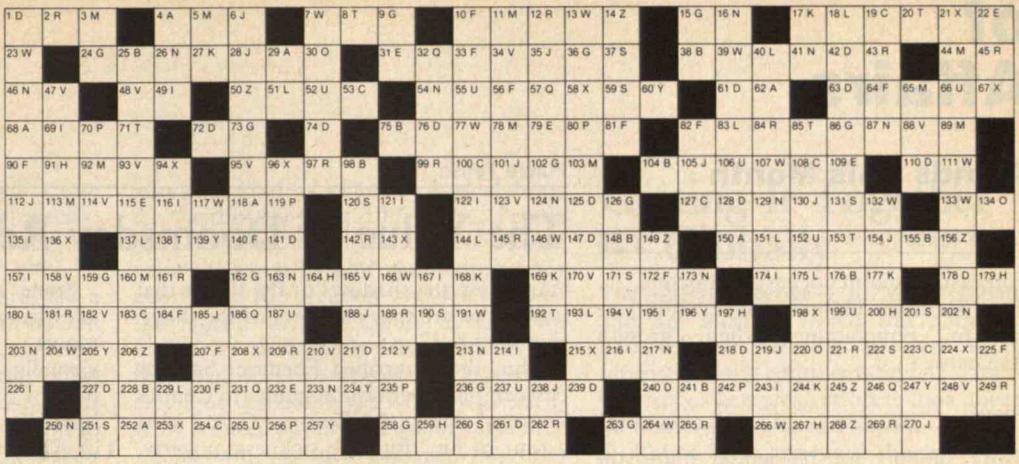
Redistribution of our technological resources is the key to reversing the progressive debilitation of the U.S. economy. Yet doing so requires nothing less than a shift in national priorities. The problem is not so much one of economic policy as of political will. □

Sparks and Lightning

Complete the word definitions; then enter the appropriate letters in the diagram to complete a quotation from an early description of x-ray fluoroscopy.

The first letters of the defined words give the author and title from which the quotation is taken. Black squares in the diagram indicate ends of words; if there is no black square at the right end of the diagram, the word continues on the next line.

The solution will be in the next issue, when another of Mr. Forsberg's puzzles will also appear. Readers are invited to comment—and to suggest favorite texts for future puzzles.



A Glossy silk fabric

29 68 62 4 118 150 252

B Mythological winged monster

75 241 228 38 25 155 176 98 148

104

C Character in Johann Strauss' "Die Fledermaus"

127 223 108 100 19 183 254 53

D Fantasy by Leo Szilard, 1948 (3 wds. with "the")

218 227 42 211 239 147 110 240 178

128 72 76 1 141 74 63 125

61 261

E Noisy brawl

22 115 31 79 232 109

F Saki's avenging weasel (2 wds.)

207 56 140 81 225 184 90 33 10

64 82 230 172

G Opera by Virgil Thompson 1947 (4 wds. with "The")

24 162 263 159 9 126 15 73 36

86 258 102 236

H Nonmetamorphosing salamander, *Ambystoma Mexicana*

267 179 200 197 91 164 259

I Nocturnal Conviviality (4 wds.)

69 116 226 216 167 157 214 122 243

135 195 121 174 49

J A possible answer to the energy crisis (2 wds.)

238 101 112 188 219 105 6 35 154

270 130 185 28

K "Tsk, tsk, ____" (Ogden Nash, "Glossina Morsitans")

169 17 177 244 168 27

L Graceful English furniture style, late 18th century

83 18 180 229 51 144 40 151 193

137 175

M Friend of a large invisible rabbit (full name)

160 92 3 113 65 78 11 89 5

44 103

N Phenomenon of narrow-band gamma-ray absorption (2 wds.)

26 213 124 54 202 203 87 163 217

46 41 129 16 173 250 233

O Baseball bat material

220 30 134

P American theater and industrial designer, 1893–1958

242 80 119 70 256 235

Q Byzantine Empress, c.752–803 A.D.

246 231 32 186 57

R Kovalyov's bureaucratic title (Gogol, "The Nose") (2 wds.)

99 84 181 269 265 262 189 12 142

45 209 145 221 97 43 249 2

161

S Singer of beautiful soup (Carroll, "Alice") (2 wds.)

59 260 131 190 201 222 251 120 37

171

T Ballet by Stravinsky, 1947

153 138 192 8 20 85 71

U Term for decimeter electromagnetic wavelengths (comp.)

66 255 93 152 52 187 199 237 106

55

V Aurora Borealis (2 wds.)

114 182 210 158 123 47 34 88 165

48 248 170 95 194

W "Nor treat with virtuous scorn ____" (G&S, "Iolanthe") (1 word, 1 comp.)

7 264 111 266 166 204 23 146 39

117 77 191 13 133 132 107

X Subrahmanyan Chandrasekhar's field

58 67 215 21 143 208 96 136 94

224 253 198

Y French town on the Theols

139 212 60 196 234 257 205 247

Z Wife of Athamas, mother of Phrixus and Helle

245 14 50 156 206 268 149

Trend of Affairs

Trends This Month

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Who will stand up for U.S. innovators?

Last Line 86

At the root of ecological understanding: the American Indian.

The Value of Doomsday Reports

"Are these the shadows of the things that *will* be, or are they shadows of the things that *may* be?"

Thus did a terrified Ebenezer Scrooge beseech his supernatural guide (in Charles Dickens' classic, *A Christmas Carol*) after a tour of his "future": sickness, poverty, misery, and death — all of which, had he been a decent, compassionate, and generous person, might have been averted. Warned by his long-departed business partner Jacob Marley and a team of other spirits to change his miserly ways before it became too late, Scrooge did in fact repent. He learned to connect his life with the lives of people around him, and all became happier, healthier, and wiser — a more stable and productive society, as today's economists might say.

The U.S. Council on Environmental Quality (CEQ) and the State Department are not yet departed, and no industrialized nation likes the image of itself as an unrepentant Scrooge, but "Marley's ghost" these agencies did play last summer in their *Global 2000 Report to the President*. In understated but unprecedented fashion (this was, after all, an official government document), they warned that "unless the nations of the world act quickly and decisively to change current policies, life for most of the world's people will be more difficult and more precarious in the year 2000 than it is today."

Some shadows of the world two decades from now, according to this massive report — a three-year effort involving virtually all federal departments and a host of outside consultants — are as follows:

☐ The world population will be 6 billion (compared with 4.5 billion today), of which four-fifths will be in the poorest countries.

☐ The gap between the rich and the poor will be wider.

☐ World food production will be up, but most of the increase will be consumed by those already well-fed.

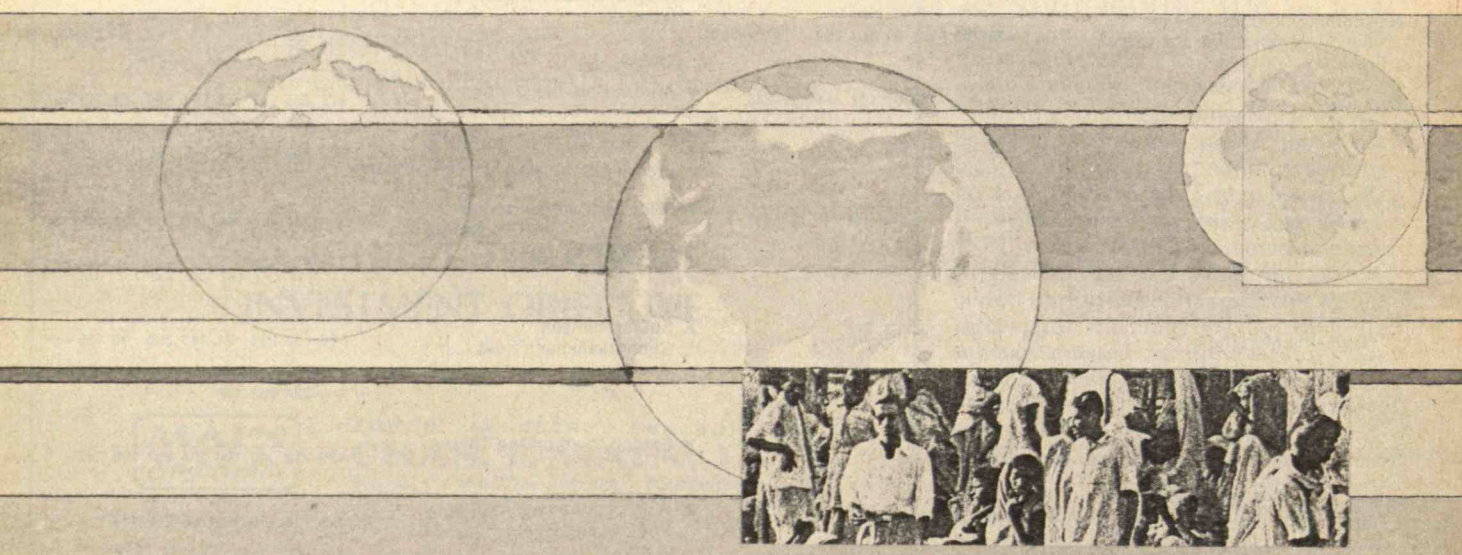
☐ The amount of arable land will have shrunk. Desertification will claim an area the size of Maine each year between now and the year 2000.

☐ The world's tight energy situation will grow tighter as prices continue to rise. Development in the poorest countries will thus be hampered, and even traditional fuels such as wood will become scarcer.

☐ Depletion of the world's forests, mostly in tropical and subtropical areas, will continue at a rapid rate.

☐ Water supplies will decrease, largely because of deforestation, and the quality of what water we have will be lower because of pollution.

☐ Air pollution, both on regional and global scales, will adversely affect health and climate.



Elizabeth Heitzmann

☐ Environmental disruption will cause the extinction of plant and animal species; 15 to 20 percent of all species now on earth could be gone by the year 2000.

Journalists throughout the world did a thorough job of relaying the numbers and registering the appropriate levels of alarm. But it is important to note that the report makes no great claims for accuracy or consistency. It explicitly calls attention to the enormous number of variables, their frequent resistance to quantification, the unavailability of important data, the primitive state of most projection models and their incompatibility when used within a larger model, the inadequate accounting for feedback effects (overpopulation exacerbates pollution, for example, but how does pollution affect population?), and the lack of a proper institutional base for the study itself. The EPA, for example, is large enough and skilled enough, but its mission is regulation, not global projection, while the CEQ, whose job *is* to project, is too small and underfunded.

Eight years ago, the Club of Rome's *The Limits to Growth* — to which *Global 2000* has been frequently compared — also warned of social and ecological disaster "within the next 100 years." People then, as now, took the numbers at face value: believers became alarmed; skeptics questioned the accuracy and relevance of the model. In *The Limits to Growth*, feedback was elegantly accounted for, but the "high level of aggregation" posed a credibility problem: the world was essentially reduced to only five major variables.

The value of such exercises has been routinely questioned because they omit certain key real-world elements — human ingenuity, for example. But neither study has claimed its value to be in the accuracy of its forecasts. Indeed, users of expert predictions are becoming increasingly aware that they can achieve their objectives even with forecasts of minimal precision (*see "The Seer-Sucker Theory: The Value of Experts in Forecasting" by J. Scott Armstrong, June/July, p. 18*). This is particularly true when cause and effect are self-evident (as in the results of unconstrained growth and depletion in a finite space).

Most important, these studies do not claim to predict the future; they are warnings, just as the message from the Ghost of the Future was a warning to Scrooge. "While the resulting prognostications are occasionally grim," says the *Global 2000 Report*, "they should not be interpreted as statements of what will actually happen, but rather as indications of what is likely to happen if societies do not develop and implement policies that will sustain the health of the environment." — *S.J.M.* ☐



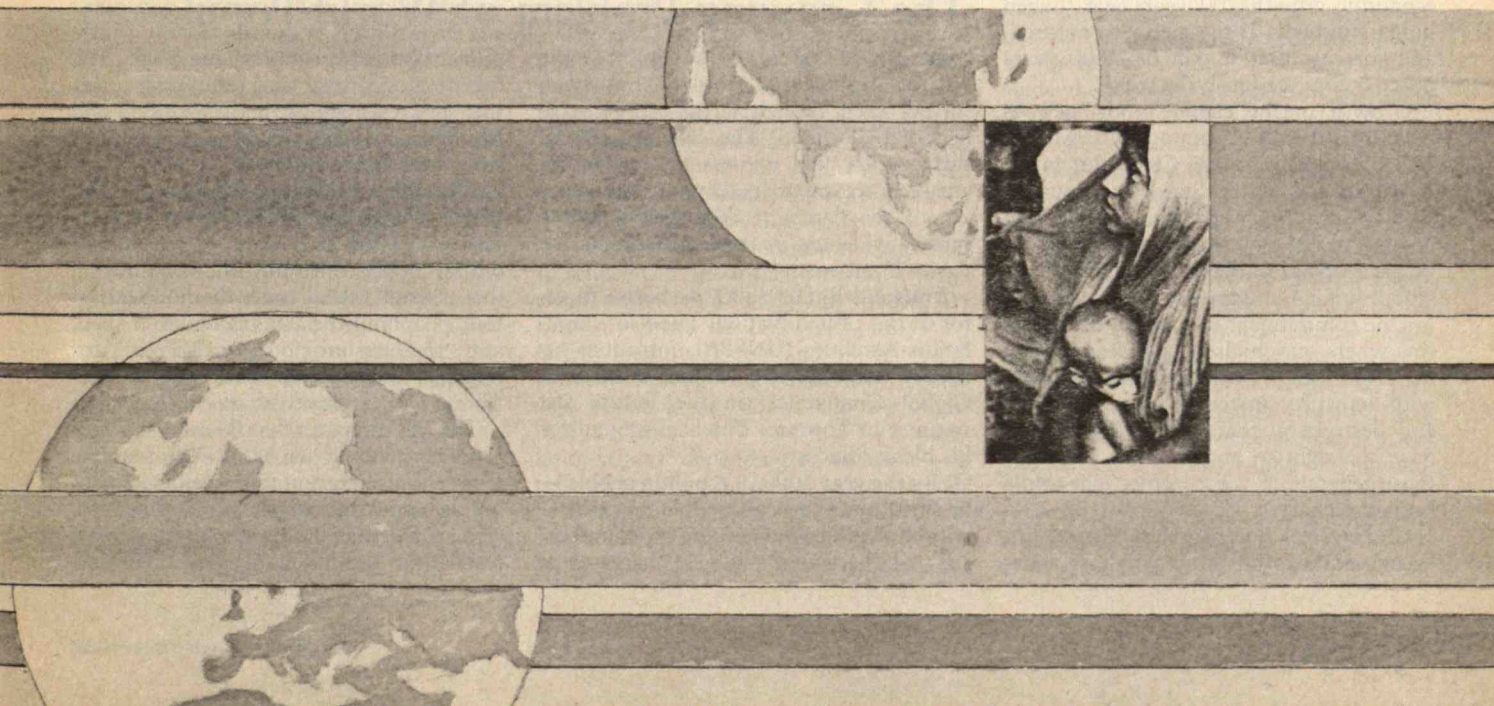
Getting It Together — Globally

The official objective — to "think globally and act locally" — of this summer's gathering in Toronto of over 4,000 futurists from 6 continents and 45 nations was truly a herculean effort to look ahead, no matter who characterized it.

☐ Rafael Salas, executive director of the United Nations Fund for Population Activities, assessed the First Global Conference on the Future as nothing short of an "effort to preserve the human species."

☐ Said Edward R. Schreyer, governor general of Canada, the conference was a therapeutic response to a "gross ambiguity of the human condition" — the disparity between have and have-not nations. He warned that if disarmament, energy, and food-supply questions remain unresolved for "one or two generations," humanity would then confront a "critical pass of probably epic proportions."

☐ The critical pass is here and now, according to Indira Ghandi, whose greeting to the conference was read by Rashmi Mayur, director of the Urban Development Institute in Bombay. "Can we ever hope to achieve a world free of tension if the greater proportion of humanity lives in want, while a small, affluent minority monopolizes the benefits of modern technology?" queried Mrs. Ghandi rhetorically. Are humans "wiser or happier" despite myriad technological advances? "Where are we going?" she asked.



☐ If ever a singular convocation could respond meaningfully to such sweeping challenges, this was it, by the estimate of Edward Cornish, president of the World Future Society. The conference was no less than "the greatest intellectual show on earth . . . a major milestone in the world future network," he said, adding, "We need better means of communicating with one another."

No doubt four frenzied days of 300-plus sessions to choose from, sandwiched between a packed calendar of warm-up and cool-down seminars, are a lot of communication, so how to do justice to such a rich and varied intellectual banquet? It's a familiar story to experienced conventioneers, and with questions of such magnitude begging substantive comment, it added up to a situation replete with frustration. Some common threads did bind the patchwork together. There were comments on growth, futurism, and war; bursts of pessimism and optimism, realism and (one might hope) fantasy. A sampling from plenary sessions:

☐ *Growth.* Simple economic growth is self-defeating because "growth creates structure; structure inhibits growth," observed Hazel Henderson, author of *Creating Alternative Futures,* who said as an example of such discontinuity: "We stand at the end of the age of petroleum . . . the end of economics as we know it."

"The limits to growth will be social and largely from self-regulation," said Herman Kahn, director of the Hudson Institute. He observed that there was very little economic growth 200 years ago "when humankind was at the mercy of nature," and forecast that it will be "200 years hence before we finish the trip."

Growth means change and "new is always difficult," pointed out Magda McHale, director of the Center for Integrative Studies at the State University of New York. We need "imagination and passion to redesign those systems that no longer respond to the management of our global human enterprise . . . and passion for the commitment to a world of tomorrow where our children's children will inherit the legacy of a world fraught less with injustice, insecurity, pain, hunger, and destruction than today. We do not have the right to amortize the future of those generations yet to come," she told a hushed plenary.

☐ *Futurism.* Bertrand de Jouvenal, French author and futurist (whose statement, owing to illness, was read by his son), offered a pragmatic recipe for forecasting. "His only method of forecasting," said the younger de Jouvenal quietly, "is not closing his eyes."

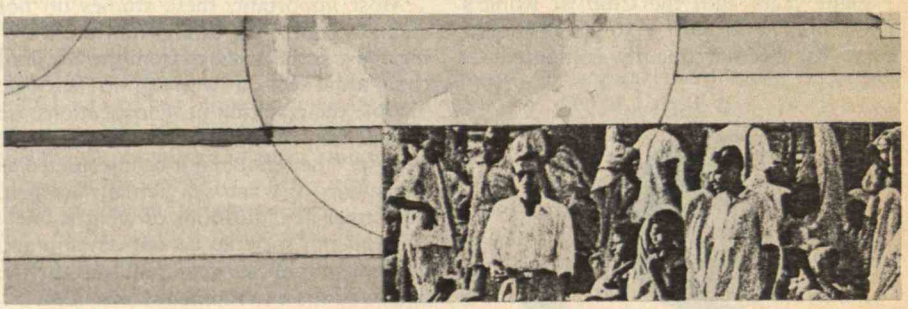
But what's real and what's not? Robert Theobald, a charismatic futurist from Wickenburg, Ariz., tested the conferees' acuity, asking: "How many of you read science fiction? [*quiet show of hands*] "How many of you don't read science fiction? [*nearly no hands*] How many of you don't know if you read science fiction?" [*laughter*] Then, more tellingly: "How many of you believe that our educational system is preparing people for the world in which they are going to live?" [*thunderous laughter and applause*]

Sustaining this worrisome note, Robert Jungk, professor of planning sciences at the Technical University in Berlin (Federal Republic of Germany), said, "The future is a place of fear, not hope . . . especially for young people," whose unrest stems from a "continuing trend toward high-risk society" and the growing possibility of the next war, "which won't be so easy to forget and rebuild from."

☐ *Survival.* Numerous speakers raised the spectre of war, but none so succinctly as Maurice Strong, honorary conference chairman: "The avoidance of war must be the number-one priority for any global management system . . . [it will be] an issue for the remainder of human history."

Some small comfort could be gleaned from the straightforward, empirical statement of faith in humanity's ability to survive made by Aurelio Peccei, cofounder of the Club of Rome. At a capacity luncheon he said, in a truly global sense, "Human stupidity is great indeed, but not so great as to be suicidal."

Mr. Strong provided a caveat especially timely for the U.S. by observing that "today's leader has more potential impact on tomorrow's issues than today's." The implications of that statement place the futurist function squarely (and locally) on the doorstep of the American voter this month. — *L.A.P.* ☐



The Growing Problem of World Population

"There is no reason to believe that the world population problem has been solved, even though fertility rates have begun to decline." The closing years of this century will witness a "further increase in the numbers of poor, a worsening of the depth of deprivation, and a further widening of the international disparity in incomes."

Thus did Rafael Salas, executive director of the United Nations Fund for Population Activities (UNFPA), introduce his agency's findings to a seminar at the First Global Conference on the Future last summer in Toronto. The background for his bleak forecast:

☐ By the year 2000, 4.8 billion people — nearly 4 out of every 5 people on earth — will be living in the developing countries, sites of the world's largest increases in population between 1950 and 1980. The less-developed countries (LDCs) are today the "poorest regions of the world," said Mr. Salas, and they are ill-prepared to absorb the projected growth.

☐ Though world grain output doubled between 1950 and 1978, population grew faster, with the result that per-capita food output increased by only one-third during that period. Today, more than one out of four people in the LDCs is malnourished, and "the facts are not very different" for housing, health care, educational opportunity, and employment, said Mr. Salas.

The UN estimates that the rate of population growth in the LDCs will decrease from about 2 percent in the mid-1960s to 1.8 percent in the early 1980s and 1.6 percent in the year 2000. The decrease will result from the cumulative effects of fam-

ily planning, the education of women, their increasing — if modest — participation in nontraditional economic activities, and a decline in infant mortality (taking some pressure off reproduction alone as a means of building a stable family size) as access to health care improves. But because today's rate is so large, this decrease in growth rate does not translate into declining total population.

The price tag for the 0.4 percent decline in population growth will be substantial. The UNFPA will commit more than $300 million over the next half decade to new programs in family planning, and the LDCs themselves will add "over $1.5 billion . . . in line with the basic philosophy of the fund to promote self-reliance."

Whatever the expense, the alternative of uncontrolled population increase is unthinkable; accommodating even the prodigious "controlled" growth of population will require innovative thrusts — and some good luck. The UN estimates that 600 million new jobs will be needed to absorb the additional — decelerated — growth expected in the labor force by the turn of the century. Other future problems outlined by Mr. Salas:

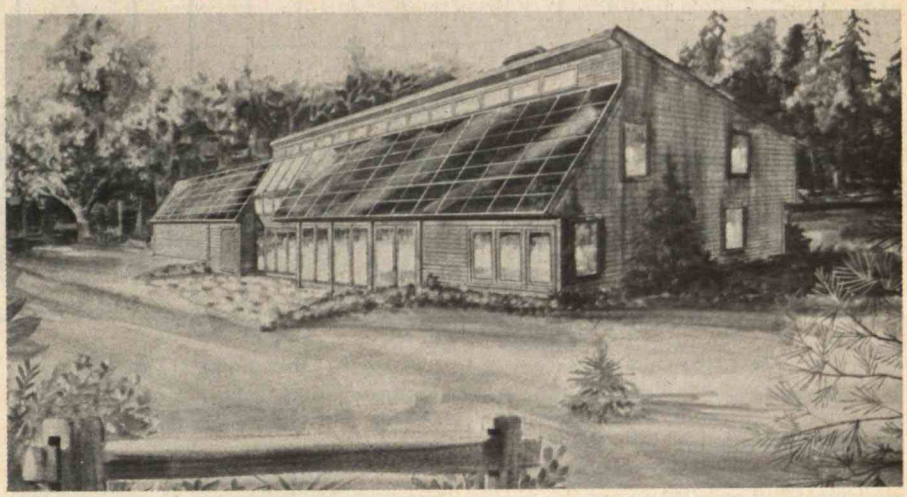
☐ The populations of some cities are likely to grow to a size "totally unfamiliar to town planners." Indeed, by 2000, there may be some 60 cities of more than 10 million people, compared with only 6 cities in 1950 and 26 cities today with populations of half that many.

☐ The proportion of younger people in the LDCs is increasing, while the proportion of older people is growing in the developed countries. These trends presage significant demands for resources in the developing countries — housing, health care, education, and consumer goods — and decreasing demands in the developed countries where they are more easily met.

☐ Women must be provided with "increasing access to decision-making processes," said Mr. Salas, warning that failure to achieve this goal will mean obviating women's "key influence . . . in fertility control, nutrition and health."

☐ Environmental concerns will become more critical as population pressures disrupt fragile ecological equilibria. The carrying capacity of the planet is a "dynamic variable," Mr. Salas said, and innovation and courage will be necessary to "initiate action in anticipation of events." To most developing countries, such thinking may seem more like oppression than prudent planning. — *L.A.P.* ☐

The first occupied photovoltaic-equipped residence in the U.S. will be built in 1981 in Carlisle, Mass., by the Department of Energy's Northeast Residential Experiment Station. The M.I.T. Lincoln Laboratory has designed a 6.9-kilowatt (peak) residential photovoltaic system with a 21-by-48-foot array of silicon cells for the house, and four other contractors are competing to build the turnkey system. Meanwhile, similar houses are being designed by DOE regional centers in Cape Canaveral, Fla., and Las Cruces, N. Mex. The idea is to give builders, bankers, insurance agents, and building-code officials "laboratories" in which to learn about photovoltaics.



Energy

Electricity Off the Roof

The house you build in 1986 may well be powered — at least on sunny days — by its own array of photovoltaic cells, and even photovoltaic retrofits of existing houses may be economical during the 1980s.

Such visions of a photovoltaic future have traditionally hinged on new technology to reduce the prices of the photovoltaic cells themselves. They still do: the Department of Energy's goal has been to have photovoltaic cells on the market at 70 cents per peak watt by 1986, with installed residential photovoltaic systems to cost no more than $1.60 per peak watt.

The program to reduce the cost of photovoltaic cells is on schedule. Indeed, progress has been "so substantial" that reducing the cost of peripheral equipment, installation, and maintenance now looms at least as important as reducing the cost of the cells themselves, says C.H. Cox III of M.I.T.'s Lincoln Laboratory.

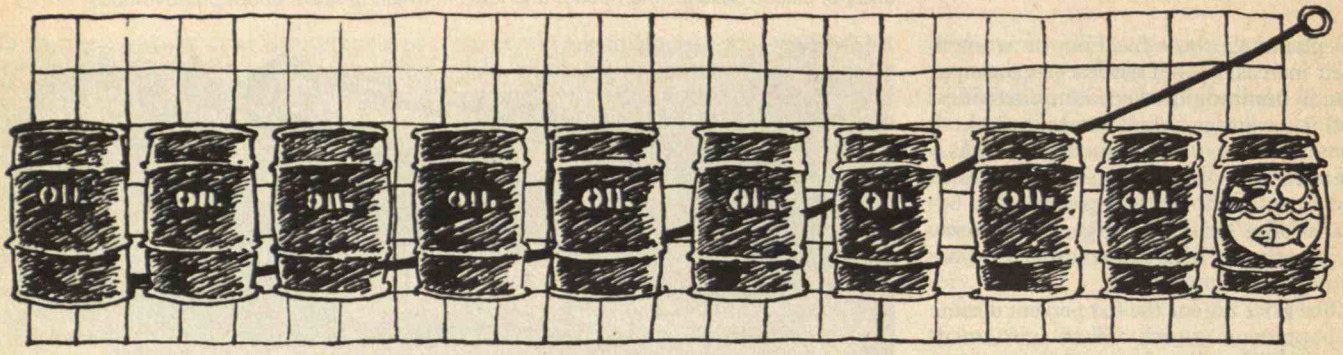
Photovoltaics have significant potential to reduce U.S. fossil-fuel demand. On average, each U.S. housing unit used 8,500 kilowatt-hours of electricity in 1979, largely made with coal and oil. A typical residential photovoltaic system with solar cells covering the roof of a house might produce from 6,000 to 10,000 kilowatt-hours a year, depending on location — a tidy fit with typical residential demand. Such systems represent "the most promising renewable energy option" to meet growing demand for residential electricity, according to Edward C. Kern, Jr. of Lincoln Laboratory, who joined Mr. Cox in reporting on residential photovoltaic developments to the Intersociety Energy-Conversion Engineering Conference in Seattle last summer.

In addition to the photovoltaic cells themselves, there will be three major categories of cost in building and operating residential photovoltaic systems, Mr. Cox told the IECEC:

☐ Installation and wiring. It's assumed that the photovoltaic cells will be assembled into 3-by-8-foot modules each weighing 50 to 60 pounds. Several of these will have to be hoisted to the roof, assembled in a waterproof array, and connected with weatherproof wiring. The cost will be somewhere between 45 and 80 cents per peak watt.

☐ Power conditioning. Photovoltaic cells produce direct current that varies with the intensity of sunlight. This output will have to be converted to alternating current for household use. If surplus energy is to be sold, that current will have to be at exactly the voltage and frequency required by the buyer — presumably the electric utility company. Development of power conditioners to do this job (and to provide protection from lightning and other overload for the array) is only beginning, and prices quoted to Mr. Cox by would-be manufacturers range from $.14 to nearly $1 per peak watt. Installation and wiring costs will add $400 more per system.

☐ Operation and maintenance. No one



Jon McIntosh

can guess what maintenance costs may be, since the failure rate of photovoltaic cells in residential operation is unknown. But it is clear that insurance and regular cleaning and inspection will be required, costing from $200 to $300 a year.

Given all these costs, is installation of economical residential photovoltaic systems possible by 1986? Yes, said Mr. Cox, the $1.60-per-peak-watt goal "appears attainable" — assuming continued success with silicon-based photovoltaic cells. "Intensive development efforts" are also needed on power-conditioner design and array installation. But all these efforts will be nullified, Mr. Cox said, if markups on systems and components are pushed to over 30 percent by "an unwieldy marketing and distribution chain." — *J.M.* □

Solar-Made Fuels

The fossil people think the solar people are flaky. And the solar people want nothing to do with all that dirty coal.

D.W. Gregg and colleagues at Lawrence Livermore National Laboratory have adopted what amounts to a mediator's role in this confrontation. Dr. Gregg told the 1980 Intersociety Energy-Conversion Engineering Conference in Seattle that solar energy might replace fossil energy in at least a dozen steps in fossil-fuel refining and conversion processes. Because some of the solar energy entering the process would be stored as chemical energy, solar could "potentially have a major impact" on four of these processes.

Dr. Gregg and his colleagues began their studies with coal gasification, a process in which coal is decomposed by heating with steam to about 1100° K in the absence of air to produce "syngas" — a gaseous mixture composed primarily of carbon monoxide and hydrogen. And because "syngas" can be the starting point for many other conversion processes yielding methane, methanol, gasoline, chemical feed stocks, and ammonia, solar coal gasification "could have a very large impact on our chemical economy," Dr. Gregg told the conference.

In a small-scale coal gasifier at White Sands, N.M. (using the "Lurgi" process, widely accepted for coal gasification), Dr. Gregg and his colleagues increased gas production from 20 to 50 percent using solar energy. Based on this experience, they estimate that a 12-square-mile field of solar collectors in the Southwest, all focused on a single gasification reactor, could support a commercial-sized plant. In such a plant, at least 20 percent of the heating value in the product gas would represent energy from the sun, not coal.

Potential savings are considerable: if conventional syngas costs $5.40 per million Btu's, solar-made syngas might cost $4.72, including the extra capital cost of the solar collecter system, said Dr. Gregg — and all done with current technology.

For another fruitful application of solar energy to fossil fuels, consider oil shale. In this case, the requirement is to heat the oil-bearing shale to just over 500° C as quickly as possible. According to preliminary small-scale experiments at White Sands, substituting solar for fossil heat might increase the yield per unit of fossil fuel by 10 to 40 percent. The required solar collectors might save from $1 to $3 per barrel of product, depending on the grade of the shale. Fortunately, the richest shale resources in the U.S. are in a sunny region, and Dr. Gregg therefore concludes that "a solar oil-shale-retorting process will be considerably more efficient than alternative retorting processes."

The two other major applications of solar energy to fossil-fuel processes are yet to be investigated, but also seem promising to Dr. Gregg: the flooding of oil fields with steam to increase production, and enrichment of medium-Btu "syngas" to methane (pipeline-quality synthetic natural gas). — *J.M.* □

Oil: 10 Percent for the Environment

The U.S. petroleum industry's annual cost to meet environmental regulations is projected by Battelle Memorial Institute to be $13 billion this year and more than $17 billion by the end of the decade. That averages out to $2.20 (all 1979 dollars) per barrel of refined petroleum products from domestic sources in 1990. That will represent a minimum of 10 percent added to everyone's gasoline, oil, and petrochemical bills, says William J. Sheppard, who directed a major study sponsored at Battelle by the American Petroleum Institute.

Mr. Sheppard's figures are higher by an order of magnitude than those of the Environmental Protection Agency in its 1979 report to Congress. However, the latter considered only the impact of the Clean Air and Clean Water Acts, allowed only 10 percent (instead of 12.5 percent) for the cost of capital, and placed some of the costs of producing environmentally acceptable products on consumers instead of the industry, Mr. Sheppard says. Neither EPA's nor Mr. Sheppard's figures include the costs of environmental controls required on devices that use petroleum products — catalytic converters on cars, for example.

Pollution-abatement technologies are capital-intensive, and the cost of capital is the single largest factor in the projected $2.20 price "surcharge." In 1980, oil companies will invest $2.28 billion, out of their total capital budgets of just over $50 billion, for activities related to environmental protection. By 1990, they will have invested a total of at least $57 billion to meet environmental regulations, says Mr. Sheppard.

By far the most expensive regulations today are those in the Clean Air Act — the requirements for lead-free gasoline and low-sulfur oils, for example, and for

emissions controls at oil fields and refineries. Next come controls involving water — the disposal of sludges from refineries, brines from oil and gas production, and drilling muds, and security for underground water supplies.

But regulations in the new Resource Conservation and Recovery Act (RCRA) may be even more costly. RCRA calls for security, monitoring, record-keeping, and bonding of oily wastes, which are designated "hazardous" since they are ignitable, in what are called "production pits" at producing sites and refineries. Indeed, uncertainty in how the RCRA will be interpreted figured heavily in Mr. Sheppard's warning to a sympathetic audience at the American Chemical Society's national meeting last fall that the industry's pollution-control costs could be as high as $65 billion a year by 1990. In the "most restrictive" future scenario (with "extreme" interpretations of existing legislation and "severe" future legislation), environmental costs could add $8.40 per barrel to the cost of refined oil products in 1990 — a surcharge of about 30 percent.— *J.M.* □

Agriculture

The Fine Future for Fertilizer

Jolted by the rising cost of energy, lower-quality phosphate resources, and new environmental constraints, the U.S. fertilizer industry is in the midst of significant technical change. But "no dramatic new breakthroughs or 'miracle' innovations are likely," Charles H. Davis, director of chemical development for the Tennessee Valley Authority (TVA), told the American Chemical Society at their national meeting late last summer.

Here are some highlights of a symposium there on fertilizer developments that support his prediction:

□ There has been steady improvement in making ammonia (the vehicle for the nitrogen that is the principal plant food in fertilizer) with and from natural gas. To produce one ton of ammonia by conventional technology requires 40,000 cubic feet of natural gas, a whopping 70 percent of all the energy needed to make and distribute the fertilizer. The Fertilizer Institute says gas consumption per ton of ammonia went down 3.2 percent between 1978 and 1979, and improvements are expected to continue.

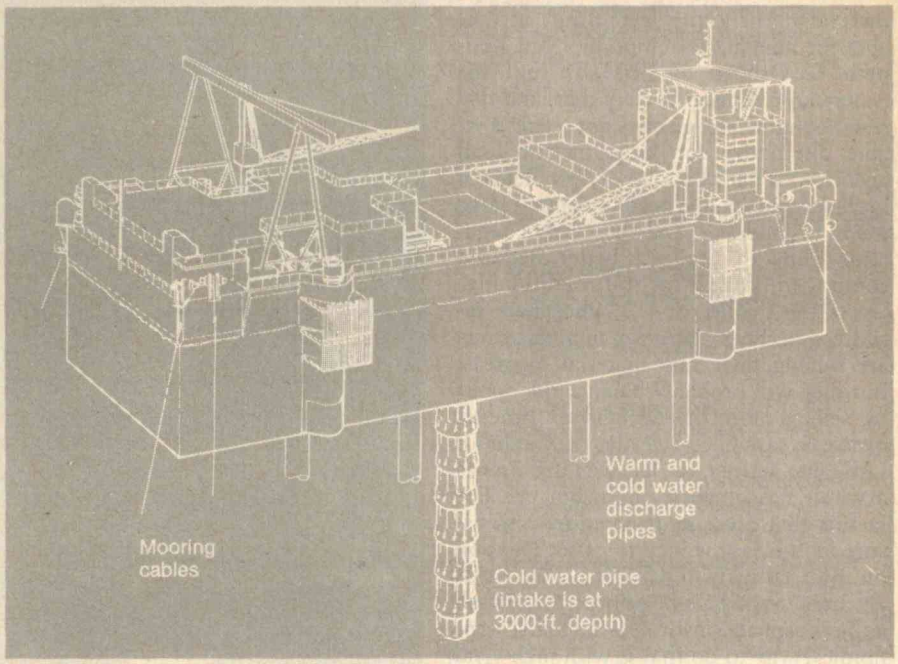
□ TVA is ready to substitute coal for natural gas in the production of ammonia. Its process will be economical when the price of natural gas reaches about $3 per 1,000 cubic feet — compared with the 1979 price of $1.62 to U.S. ammonia producers, up 18 percent from 1978. Ammonia from coal would cost a little less than $30 a ton (in 1980 dollars). That compares with a price of just over $200 a ton for ammonia from a barge-mounted ocean thermal energy conversion plant projected by the Johns Hopkins Applied Physics Laboratory (*see illustration*), which its designers say will be competitive in the 1990s.

□ The amount of nitrogen in fertilizer available to crops is being increased. It's a fertile field for increasing efficiency: often no more than half the nitrogen in fertilizer reaches the intended crop. The rest (which may represent as much as 200 trillion Btu's of energy a year in the U.S., Dr. Davis said) runs off, leaches unused into the soil, or is volatilized into the air. Remedies include incorporating the nitrogen into pellets for gradual release and including inhibitors to slow down the soil microbes that turn nitrogen into plant food.

□ Sludge from sewage treatment plants can be added to chemical fertilizers. Most sludge has value as a soil conditioner but little as a plant food; and two problems must be solved before the sludge is added: the sludge must be dried, and its content of heavy metals and toxic chemicals controlled. Drying is expensive but not out of the question; however, cleaning up the sludge appears to be uneconomical if more than modest quantities of hazardous materials are present. James C. Barber and Michael B. Moeller, reporting on their work at the University of North Alabama, said that "the fertilizer industry may have little interest" in sewage sludge as a fertilizer extender because of these problems. But the jury may still be out. D.A. Mays, a research agronomist with TVA using the same Florence, Ala., sludge as Messrs. Barber and Moeller, found that yields of corn were as good in the summer of 1979 in a field fertilized with about four tons per acre of sludge as in a "control" field treated with commercial fertilizer. Soybeans and cotton, which require less nitrogen, did not do as well. Florence sludge contains small amounts of cadmium and zinc, and the corn plants in the sludge-treated field contained these metals, but the grain did not.

A similar test was less successful for the East Bay Municipal Utility District of Oakland, Calif. This sludge contains higher concentrations of heavy metals because of the heavy industry along San Francisco Bay. Various test crops did well enough on EBMUD's sludge-treated lands, and although there were "measurable concentrations" of heavy metals in

Fertilizer factory of the future? Perhaps — but in the distant future. The sketch shows a barge-mounted, 40-megawatt electric plant generating energy for the electrolysis of sea water to make ammonia, the result of a design study by the Johns Hopkins Applied Physics Laboratory (APL). Electricity would be generated by using the warm surface water of the tropical ocean to expand a gas previously cooled by cold water drawn up from 3,000 feet below. The "grazing" plant would roam the oceans in search of the greatest temperature differentials, producing up to 1,000 tons of ammonia per day.



the plants, the grains were "fully acceptable for animal consumption." But Kenneth E. Osborn of EBMUD told the American Chemical Society that land disposal of liquid sludge does not seem "a viable alternative for large metropolitan agencies." That's because of "problems of local acceptance, the need to commit large tracts of land, . . . and the current regulatory climate." Sludge is better used as a composted product for soil conditioning. □ As the quality of U.S. phosphate resources declines, fertilizer manufacturers are buying their raw material overseas. But they will probably balance the books by selling more of the finished product overseas, says G.C. Sweeney of Arthur D. Little, Inc. Indeed, the fertilizer business as a whole has nowhere to go but up. The factors that cause its frustrations also assure its future: the way to offset inflation on most farms is to achieve higher yields per acre. Says J.D. Beaton of the Potash and Phosphate Institute, the most economical way to do that is with high-yield fertilizers.— *J.M.* □

Materials

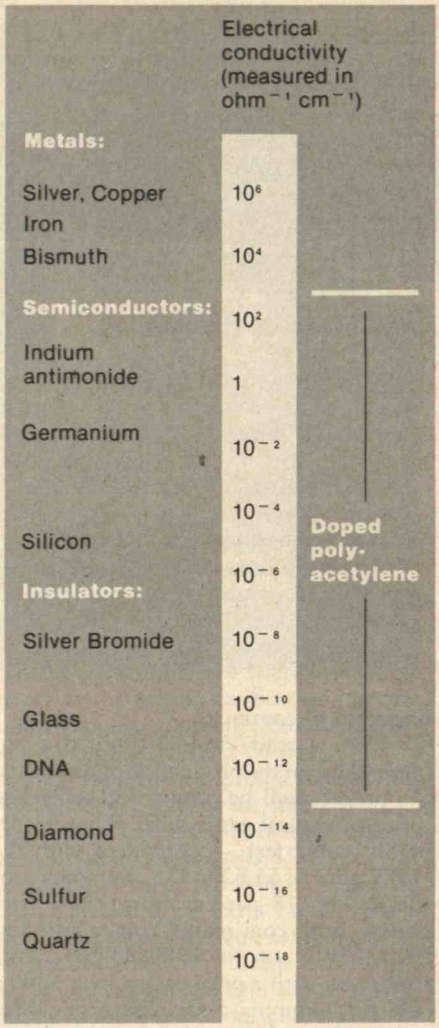
Synmetals: Good as Gold?

In the beginning, God created metals and everything else. In the ensuing period, humans became fascinated by the properties of metals, including their ability to conduct electricity, a capacity that until recently it seemed that metals alone enjoyed.

In the past few years, however, scientists found they could induce electrical conductivity in normally nonconducting materials through artful "doping" techniques similar to those used to make semiconductors. (Doping certain substances with traces of appropriate elements produces electrons that are loosely bound to their original atoms and therefore readily wander through the substance, just as electrons do in natural metals. Doping may also generate "holes," created by the absence of electrons and behaving like positively charged electrons.) By varying the amount of dopant, researchers have been able to produce a range of conductivity in certain polymers that spans 11 orders of magnitude — from insulator to metal.

In such synthetic metals, or "synmetals," electrical conductivity can be combined with a host of useful properties not found in metals. Real excitement exists that wholly new technologies may arise to exploit these new materials.

A comparison of electrical conductivities attainable in variously doped polyacetylene with some familiar substances.



With industrial leaders such as IBM, Bell Laboratories, Xerox, and Allied Chemical now getting into the act, synmetals may well be "the fastest growing field," speculated polymer scientist Raymond B. Seymour of the University of Southern Mississippi at the American Chemical Society's meeting last August. Others at the meeting likened the situation to that of synthetic fibers some 50 years ago, when nylon was first discovered at DuPont. And just as synthetic fibers have created their own niche in modern life, synmetals may make themselves equally indispensable.

Some tantalizing possibilities for synmetals have already been hinted at. French researchers recently demonstrated that a substance belonging to a class of organic chemicals known as charge-transfer salts becomes superconducting when subjected to tremendous pressure and near-absolute-zero temperatures. Efforts are now aimed at custom designing salts that will superconduct at the comparatively higher, and hence more practical, temperature of liquid nitrogen (77° Kelvin or −196° C).

Other researchers are investigating certain compounds of graphite in which molecules are arranged in layers like pages in a book. By itself, graphite is a poor conductor, but when compounds such as arsenic pentafluoride or nitric acid are inserted between the layers, it can be made as conductive as copper. However, F. Lincoln Vogel, the University of Pennsylvania researcher responsible for that feat, admits "we can't yet do it at will."

Conductive graphite might one day find practical applications in transmission lines and lightweight wiring — in aircraft, for example. Considering the miles of cable in an airplane, a switch from metal to graphite could represent an enormous savings in weight and, subsequently, energy. The federal government has been quick to catch on to the new materials' potential and now provides about $5 million a year for synmetals research, much of it from the Department of Defense.

Most promising of all are the doped polymers that combine satisfactory conductivity — better than mercury in some cases — with low cost, light weight, flexibility, and strength. Furthermore, the polymers can be chemically tailored to have a variety of useful characteristics. The new polymers can be made to conduct only in the presence of light, heat, or pressure, to switch between conducting and nonconducting modes on command, and to conduct in one dimension only (along aligned polymer chains) — almost anything short of rolling over and playing dead.

For example, Alan J. Heeger and Alan G. MacDiarmid, professors at the University of Pennsylvania and pioneers in synmetal research, found that polyacetylene — made from common welding gas — can convert light to electrical energy and might therefore be made into solar cells. While present materials fall far short of the 10-percent conversion efficiency routinely attainable with silicon solar cells, synmetals provide numerous advantages over single-crystal silicon cells.

Professors Heeger and MacDiarmid

have also designed a rechargeable battery from polyacetylene. The battery material, consisting of a golden, plastic-wrap-like film of polyacetylene doped with lithium iodide, is a mere 0.1 millimeters thick and produces about 2.8 volts. Higher voltages and currents can be achieved by layering the material. The potential of such thin, light batteries is tremendous, and the technology and application of electrical storage stand ready for a revolution.

Despite rapid advances — there are now some half-dozen conducting polymers under investigation compared with just one little over a year ago — synmetals face a long road to commercial success. In general, the materials are less conductive than many metals, though high conductivity is not necessary for some applications. Many of the polymers cannot be manufactured by standard plastics technology, and some of the dopants are highly toxic and tend to evaporate out of the materials. But the major problem is that the polymers tend to deompose when exposed to air, water, or high temperatures.

On the optimistic side, each of these problems has been solved for at least one or another of the synmetals now being studied, and the challenge is to come up with the unique product that will solve all the problems in one fell swoop. Researchers are confident that, with continued rapid growth and high interest in the field, they will overcome these difficulties. — *J.K.* □

Solution to October Crostic

Realizing that, as one observer put it, "The humblest bacterium can synthesize, in the course of its brief existence, more organic compounds than can all the world's chemists combined", scientists are stepping up their investigations both of ancient folk medicines and of hitherto unused plants with intriguing chemical properties.

Erik Eckholm, "The Age of Extinction"
The Futurist, October 1978

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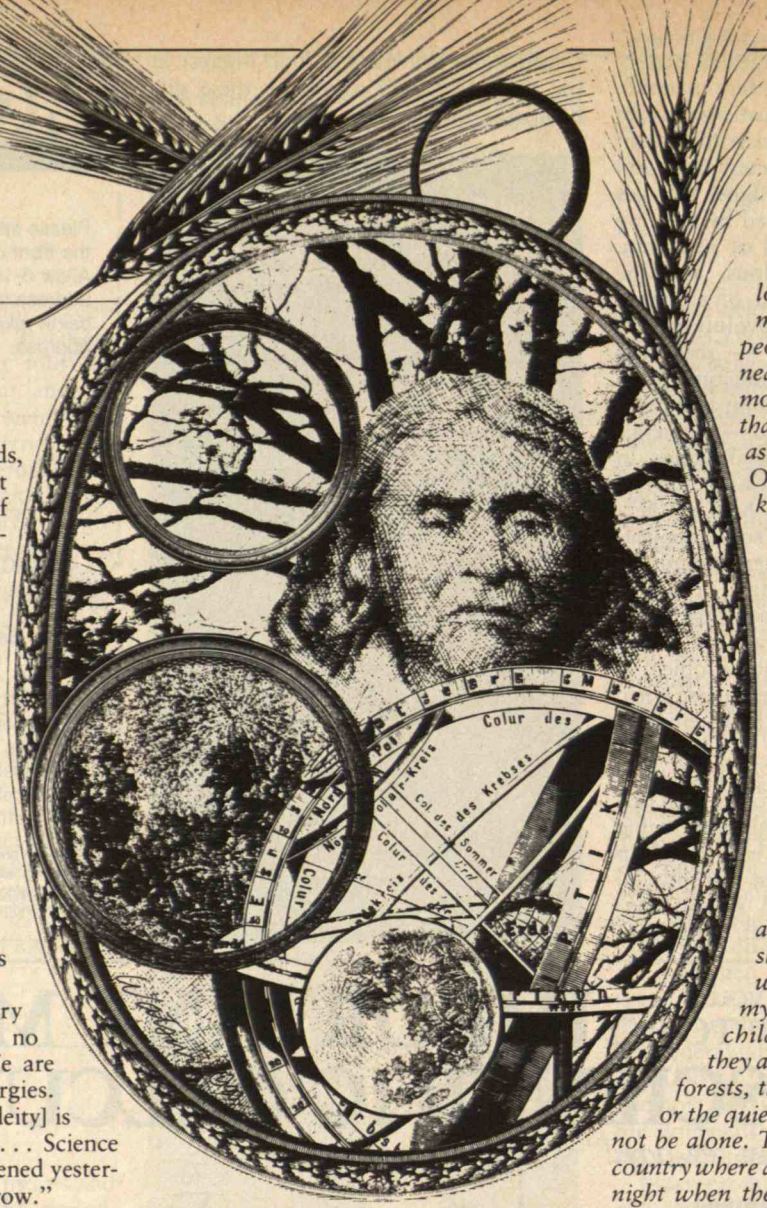
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Last Line

Where There Is Peace



The words of Bobby Woods, a 'Ksan Sioux Indian, at first seemed strangely out of place in the plush, air-conditioned room of the Toronto luxury hotel, site of the First Global Conference on the Future:

"There is no place on earth where there is peace," he said. "White men say, 'Pick up your arms. We'll go and fight for peace.' [*pause*] I don't understand it."

Every eye in the room was now riveted on Bobby and you could hear uneasy listeners shifting their weight as the impact of his message struck home.

"Mother Earth is very tired," he said. "There is no more oil, no more gas. We are draining her of her energies. Grandfather [the supreme deity] is trying to restore her, but . . . Science can tell you what has happened yesterday, today, but not tomorrow."

Added Ernie Benedict, a Mohawk elder, "Yours is a law of ownership and dominion. Our law is the brotherhood of all creatures. We see you as a people without restraint."

"We must approach things in a sensible, simple way," said Patrick Madahbee, spokesperson for the Union of Ontario Tribes. "We must not try to reinvent the wheel."

It has long been so, evidenced by a speech composed in 1855 by Chief Seattle, a Suquamish Indian, that was introduced to the seminar by moderator Gary Sycalik, editor of *Technology Tomorrow*. In that room jammed full of futurists, the long-silent words of the chief — on the occasion of his people being moved onto reservation land by the U.S. government — had a special kind of resonance. The following excerpt is from the speech authoritatively recast by William Arrowsmith, professor of classics at Johns Hopkins University.

Once my people covered this land like a flood-tide moving with the wind across the shell-littered flats. But that time is gone, and with it the greatness of tribes now almost forgotten. . . .

A few more moons, a few more winters, and none of the children of the great tribes that once lived in this wide earth or that roam now in small bands in the woods will be left to mourn the graves of a people once as powerful and as hopeful as yours.

But why should I mourn the passing of my people? Tribes are made of men, nothing more. Men come and go, like the waves of the sea. A tear, a prayer to the Great Spirit, a dirge, and they are gone from our longing eyes forever. Even the white man, whose God walked and talked with him as friend to friend, cannot be exempt from the common destiny.

We may be brothers after all. We shall see. . . .

Every part of this earth is sacred to my people. Every hillside, every valley, every clearing and wood is holy in the memory and experience of my people. Even those unspeaking stones along the shore are loud with events and memories in the life of my people. The ground beneath your feet responds more lovingly to our steps than yours, because it is the ashes of our grandfathers. Our bare feet know the kindred touch. The earth is rich with the lives of our kin.

The young men, the mothers and girls, the little children who once lived and were happy here still love these lonely places. And at evening the forests are dark with the presence of the dead. When the last red man has vanished from this earth, and his memory is only a story among the whites, these shores will still swarm with the invisible dead of my people. And when your children's children think they are alone in the fields, the forests, the shops, the highways, or the quiet of the woods, they will not be alone. There is no place in this country where a person can be alone. At night when the streets of your towns and cities are quiet, and you think they are empty, they will throng with the returning spirits that once thronged them, and that still love these places.

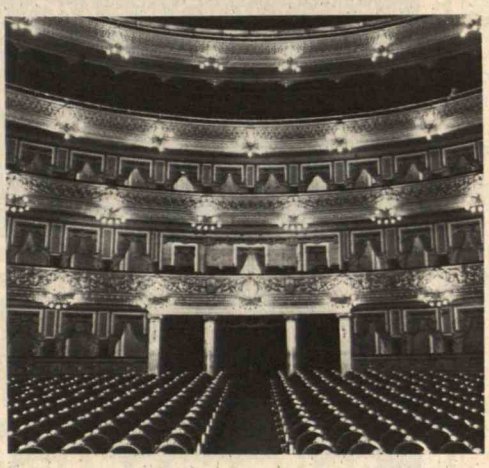
Far from a maudlin sentiment, the speech of this remarkable chief was an eloquent, moving expression of a people living in complete harmony with their environment, so literally a part of their land that they considered even death to be part of existence. Such realization of connectedness with the earth, if attained by modern technologists and policy-makers, could lead toward prudent restraint in our ever-more-ambitious plans for abundance and peace.

And, having lived with this perception all his life, Bobby Woods told the seminar of his disappointment with non-Indian futurism with noticeable impatience. "All I've seen and heard in this conference is doomsday," he said. "We [Indians] have been preparing ourselves for a long time." — *L.A.P.* □

Photo of Chief Seattle, or Sealth, courtesy of Historical Society of Seattle; collage by Karen Watson.

Buenos Aires: 400 Years Young.





One of the world's great cities is celebrating its 400th birthday this year: Buenos Aires, the capital of Argentina.

And many of the world's great have come to help celebrate—including Queen Sophia of Spain . . . President Joao Baptista Figueiredo of Brazil . . . Mayor Maurice Ferre of Miami . . . Mayor Tom Bradley of Los Angeles . . . Mstislav Rostropovich and the National Symphony Orchestra . . . Zubin Mehta and the Philharmonic Orchestra of Israel . . . and countless others.

Looking at metropolitan Buenos Aires today, with its nine million inhabitants, soaring skyscrapers, busy factories, bustling airports, crowded theaters and modern hospitals, it is difficult to imagine its birth in 1580 as a tiny village of barely 200 people on an unknown river thousands of miles from civilization.

For nearly 200 years, the town slept until in 1776 the viceroyalty of the Rio de la Plata was created with its seat in Buenos Aires.

Between 1860 and the First World War, European immigrants arrived by the hundreds of thousands, swelling the city's population. In 1905, it was one million; in 1927, it was two million; in 1947, it was nearly 4.7 million, making it the largest Spanish-speaking city in the world.

Why have so many come to live in Buenos Aires? Wouldn't you, if you could live in a city which:

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- Features more than 12 universities, 50 museums, 500 libraries and 40 theaters, including the world famous Teatro Colon opera house.
- Is ringed with plazas, parks and tree-lined boulevards—and blessed with a year-round temperate climate.
- Boasts more than 50 different *barrios* or neighborhoods—and is the birthplace of the tango and the home of the best steaks in the world.
- Plays almost every sport under the sun, hosting and winning, for example, the 1978 World Soccer Cup at its River Plate Club stadium, the nation's largest.
- Has four TV channels, nine daily newspapers, more than 50 major magazines and 25 publications in foreign languages.

Buenos Aires is a city about which it is easy to use superlatives. And they are all true.

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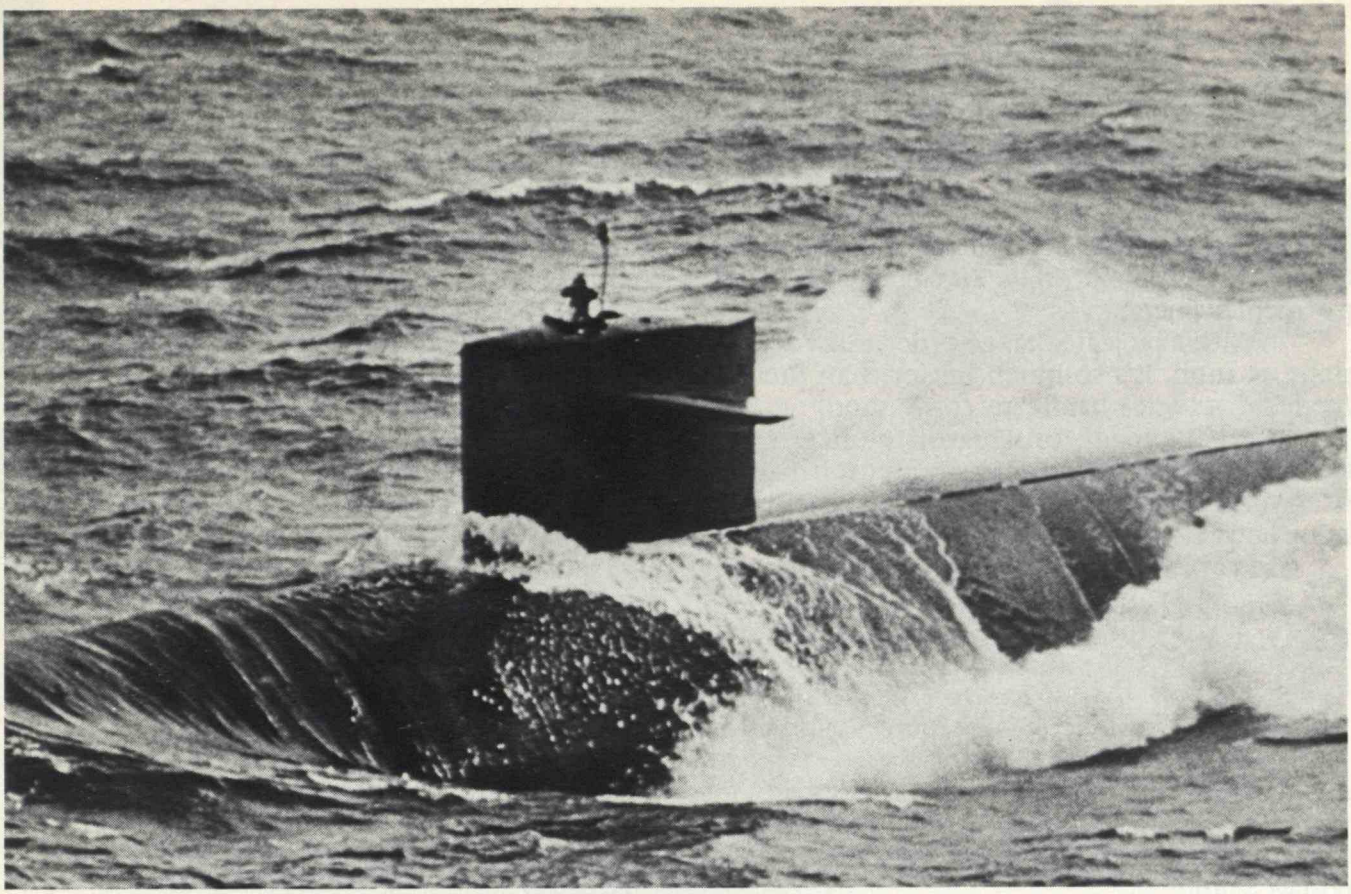
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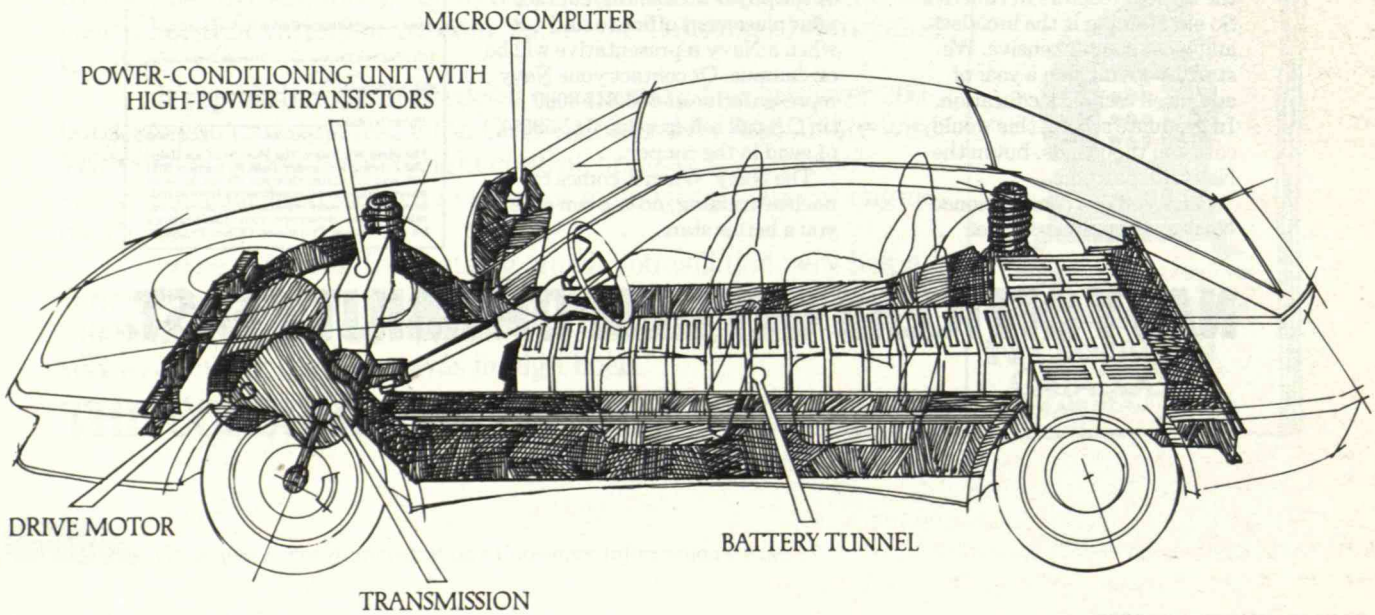
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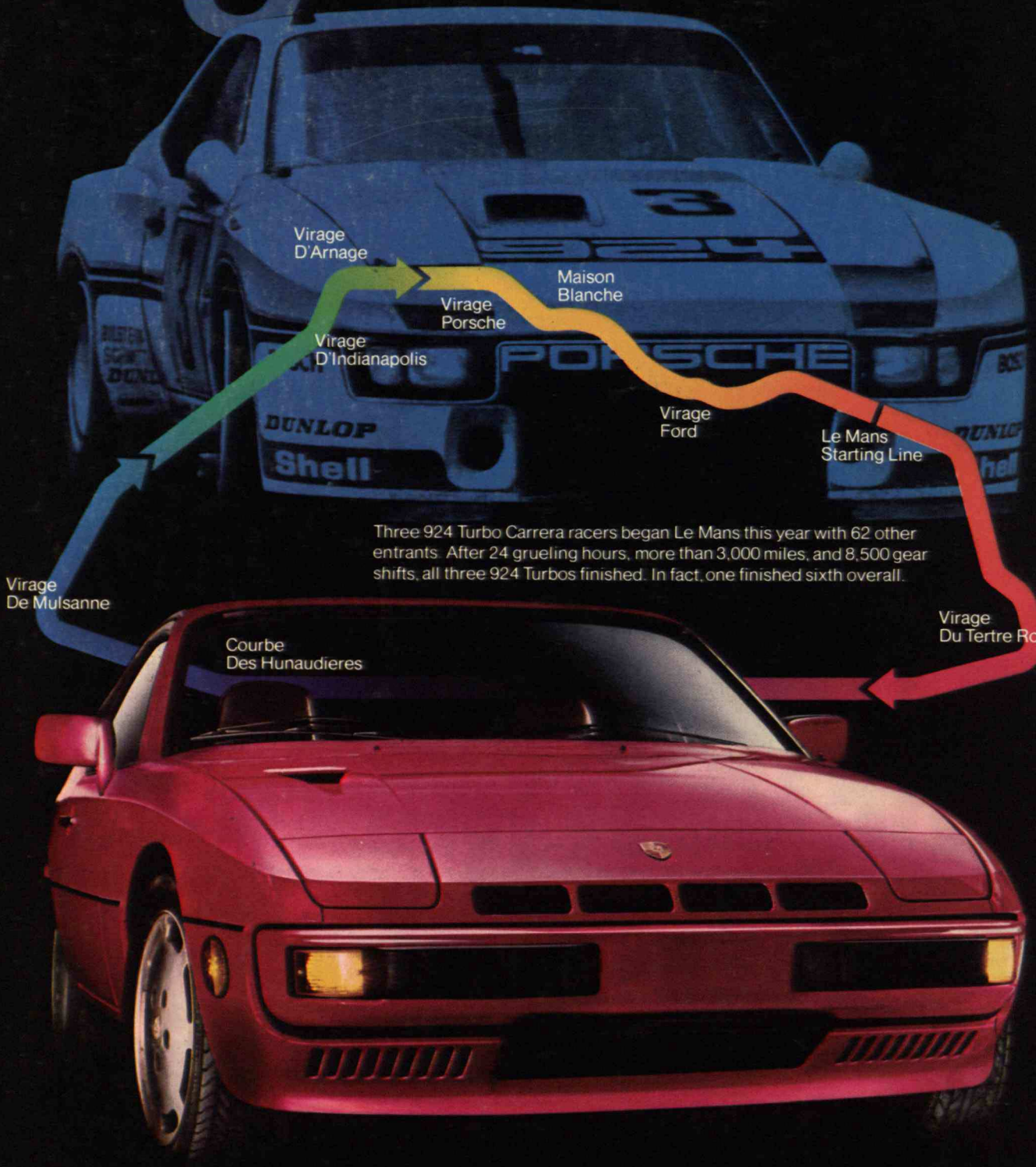
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Three 924 Turbo Carrera racers began Le Mans this year with 62 other entrants. After 24 grueling hours, more than 3,000 miles, and 8,500 gear shifts, all three 924 Turbos finished. In fact, one finished sixth overall.

At Porsche, our goal is to put the best engineering into our cars. But for every problem, there are a number of solutions. And the merits of each one can be debated endlessly. So for us, the ultimate test is racing. Because on the track, under the stresses, surprises, and realities of competition, the best solution will win. Using the race track as a proving ground is expensive, and often frustrating. But we believe the rewards are well worth it. What we learn from our race cars, we put into our street cars. At Porsche, excellence is expected.

The 917 Turbo Can-Am champion made turbocharging practical for road racers with its unique bypass valve system—standard equipment on the 924 Turbo street car. Test drive the 924 Turbo. For your nearest dealer, call toll-free: (800) 447-4700. In Illinois, (800) 322-4400.

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